DISEASES OF THE PIG

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A Handbook of the Diseases of the Pig with an Introduction to its Husbandry

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PREFACE TO THE FIFTH EDITION

When this book first appeared in 1940, the general interest in pig-rearing was confined to the agriculturist and the veterinary surgeon. Since the second world war, however, and in particular during the last decade, vast strides have been made in the development of the pig industry. Elaborate research by many organisations has resulted in an enormous advance in our knowledge of the pig and its problems and many different facets of human endeavour have become involved in the general pattern. The man farming pigs on a large scale, the cottager, the veterinarian, the meat inspector, the public health officer, the medical officer of health, the agricultural, medical and veterinary student, all require information on a wide range of topics associated with pig-rearing. It is hoped that this book will be of value to these several groups of people.

In the preparation of this new edition we have made an extensive revision and included a considerable amount of new material. The most important changes are as follows: the descriptions of methods of therapy have been brought up to date. The various sections have been pruned and rearranged for greater convenience of reference. Many have been rewritten. A new chapter on diseases of newly-born and young pigs has been included to mark the economic importance of this aspect of the subject. Some of the less informative illustrations have been replaced by new photographs and the lists of reference have been greatly enlarged. Details of the technique of tuberculin testing are given in the first appendix and to avoid unnecessary repetition in the text, posological details of the commoner preparations used in the medical treatment of pigs are listed in the second appendix.

The task of preparing a new index was kindly undertaken by Mrs. M. B. Bailey, A.L.A., to whom we are greatly indebted. Our thanks are also due to Dr. Aage Thordal-Christensen for his work on Enzootic Paresis of pigs in Denmark, and to the publishers, Messrs. Baillière, Tindall and Cox in the person of Mr. R. F. West, for unfailing help throughout. We trust that the

innovations and improvements in this edition will enable the book to be of practical value to all those persons interested in the subject, who have not had the opportunity of recent post-graduate study to familiarize themselves with the principles of current advances. At the same time the needs of the practical pig-keeper in countries abroad as well as in the United Kingdom have been kept in mind.

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January, 1961

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INTRODUCTION

THE modern pig has evolved from the rough, long-snouted, heavy-shouldered wild hog, *Sus scrofa*, and a cross with the Chinese white pig, *Sus indicus*, together with a black offshoot of the latter known as the "Neapolitan" pig. *Sus scrofa* is described as being larger, leaner, coarser in bone and hair than the white Chinese pig, whilst the wild boar was described as being of a russet grey colour when young, becoming dark brown with some grey hairs in old age, very active and dangerous. Some wild boars are said to have existed in Staffordshire up to about 1683, and up to 1593 in Oxfordshire.

The antiquity of the pig is beyond question. It has figured in mythology and religion, and although references to the pig have not always been complimentary, it is safe to say that nowadays the porcine species is regarded as one of the most useful and valuable of the domestic animals, being a prolific breeder, good scavenger, and with its small omnivorous stomach well adapted for concentrated feeding. To so high an art has pig feeding been carried that feeders can now estimate the amount of flesh the animal will produce from a given quantity of food. A pig is said to increase 1 lb. in live weight for every 3½ lb. of food consumed, or to use a rough calculation a score (20 lb.) of pig flesh (dead weight) means a hundredweight of food.

In olden days the pig's home was the great forests, where he derived nourishment from acorns, roots and beechmast. Nowadays pigs have forsaken the forests for the great grain lands and dairy countries. The corn belt of the United States of America produces the famous "lard hog," the dairying districts of Europe and Canada and the barley and potato growing areas of the world produce the pork and bacon pigs of to-day. Of all the "food animals," the pig gives most value for money, as there is no waste matter in the pig industry. The flesh is consumed as human food, and so is part of the offal, whilst the "non-edible" offals can be utilized for the production of excellent quality fats, animal foods, and fertilizers. The

skin of the pig needs no advertisement, but the custom of leaving the rind on the bacon deprives us of a valuable by-product as the difficulty of skinning such a fat animal, and the small demand for pig-skin leather, has led to the devising of machines for mincing pig skin and "rind" so fine that the product can be used for the questionable purpose of helping to act as a sausage "filler." The long back bristles of the pig make useful brushes of all sorts, whilst the shorter hairs covered with a fine layer of latex help to provide us with comfortable seats in our homes and motor-cars. The endocrine glands of pigs form valuable medicinal agents, whilst that one waste product of the pig, "the squeal," has been eliminated owing to the introduction of humane methods of slaughtering. Thus one can safely say that the pig is indeed a most economical animal.

If any criticism has to be made of present methods of pig rearing, it is that there is a tendency to regard the pig as more of a machine than a live animal, and, furthermore, an animal with peculiar idiosyncrasies. A too rapid adaptation of scientific knowledge to pig feeding and rearing has its dangers, and leads to a breakdown in the animal's metabolism with the appearance of certain disease conditions which were comparatively unknown in the pre-"scientific feeding" era. Nature exacts a penalty for any violation of her laws, and for successful rearing and feeding one must avoid extremes and try to adopt scientific methods whilst still having due regard for mother Nature.

Chapter 1

SOME BREEDS OF PIGS

Many years of careful breeding, selection and feeding have resulted in a variety of pig breeds, all of which have their good points and their bad ones, and, as the prime purpose of pig production is to provide human food, it is obvious that commercial requirements rather than breed characteristics will determine the future of many present-day breeds of pigs.

There are fourteen breeds of British pigs. Many types have been exported and they have often been used to improve native breeds. To simplify matters the British breeds may be divided into groups according to their colours, thus:

British Breeds of Pigs

White.	*Black.*	*Black and White.*	*Sandy Red.*
Large White. Middle White. Welsh. Cumberland. Long White Lop-eared. Lincoln Curly-coated. Large White Ulster. British Landrace.	Large Black. Berkshire.	Wessex Saddle-back. Essex. Gloucester Old Spots.	Tamworth.

The Large White Pig.—This is sometimes known as the Large White Yorkshire, and is said to be descended from the native Yorkshire breed. It is a very popular bacon-producing breed, especially when crossed with other suitable types, as it conforms to the bacon industry's demands for a "commercial pig" with long deep sides and wide deep hams. This breed has been exported to many lands. The excellent Danish commercial pig is a cross-bred pig—the Large White and the Danish Landrace—whilst that other good type of bacon pig, the "Irish pig," is also crossed with a Large White strain.

[Spot and General.

Fig. 1.—A Large White Sow.

The characteristics of the breed are: A white colour. Head moderately long with slightly dished face and broad snout, not too turned up. Ears long, thin and slightly inclined forward and fringed with fine hair. Neck long and fairly full to shoulders. Deep and wide chest, with shoulders not too wide. Back long, level and fairly wide, with tail set high. Sides long, averaging 15 pairs of ribs at least; belly full with straight underline. Thick and well-let-down flanks. Hams broad and full. Legs straight and well set; action firm and free. Skin free from wrinkles with long and moderately fine coat.

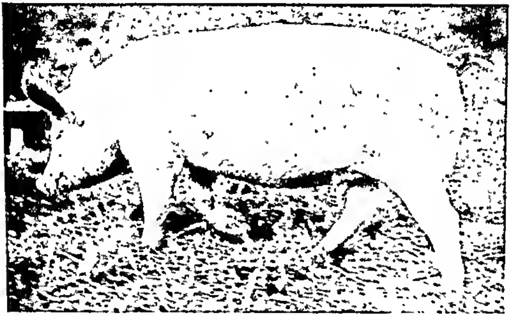


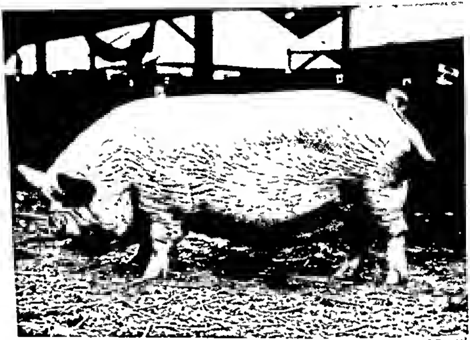
FIG. 2.—A YOUNG LARGE WHITE GILT.

Objectionable features are the presence of black hairs and pigments, a curly coat and coarse mane, hollowness at the back of the shoulder, too long or too short snout, and inbent knees.

The Middle White Pig.—This breed is also a very old one, and is said to have been evolved from crossing the Large White Yorkshire and the Small breed. Whilst the Large White is considered an excellent type of pig for bacon purposes, the Middle White is regarded as being primarily a good pork-trade pig, its small bone ensuring a good dressing percentage.

The chief characteristics of the breed are: A short head with turned-up dish face, wide between the ears. Neck full

to shoulders, which are wide with long level back. Tail set high; hams broad, full, and deep to hocks. Sides deep and level, with well-sprung ribs and full but not flabby belly having a straight under-line. The flank should be thick, with the quarters long and wide. The coat should be plentiful and of fine quality over a fine skin, free from wrinkles. Black spots and a wrinkled skin are objectionable features in this breed.



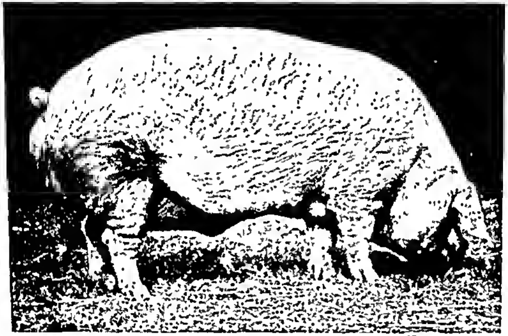
[*Sport and General.*

FIG. 3.—A MIDDLE WHITE SOW.

The Welsh Pig.—This was once known as the "Old Glamorgan," and is the only surviving distinct Glamorgan breed of farm animal. The Welsh pig is white in colour, and has been extensively used for crossing with other breeds, notably with the Large White, for bacon purposes. Although the average pig has about fourteen pairs of ribs, the Welsh tend to exceed this number, and so give a good lengthy side of bacon. The Welsh pig's head is of medium length with long, thin lop ears inclined over the face as far as the nose. The tail is long, and reaches below the hocks; eyes brown or preferably blue. Coat has a moderate quantity of straight silky hair. It has a well-

formed body, good quarters, and short straight legs. The sows are notably good mothers, and it is a first-class grazing pig of early maturity, in great demand for crossing, and has, like other breeds, been exported for that purpose. From a commercial angle, the Welsh—Large White cross-bred pig is one of the best bacon pigs in the world.

The Long White Lop-eared Pig.—This breed hails from the West of England and from Wales, and in appearance is not unlike the Welsh and the Danish Landrace breeds. It is



[*Sport and General.*

FIG. 4.—A WELSH BOAR.

pure white in colour, with a head of medium length; ears inclined well over the face. The back long and level with deep flanks. Hams large and well filled to the hocks. The hairy covering should be moderate, straight and silky. Objectionable features in this breed are a narrow forehead, dished nose, curly coat and wrinkled skin. The breed is no longer confined to its original home, and as the National Long White Lop-eared pig it is now recognised as a valuable animal for both bacon and pork production. Crossed with the Large White it produces a first-class commercial pig.

The Cumberland Pig.—This breed has hanging ears, a

dished snout, and smooth skin with only a slight covering of hair. The colour is white, although some blue spots may appear, but these are now regarded as a fault.

The Lincolnshire Curly-coated Pig.—This is again a very old breed, although its merits have been confined to its own locality for years. It is characterized by having white skin with long, abundant curly hair. Blue skin spots may occasionally appear. The snout is of medium length and straight, with ears drooping over a short face. This breed is strong and robust, being very prolific and early maturing. It is especially suitable for the pork trade, being slightly too fat for bacon, but making excellent cross-bred bacon pigs with tbe other white breeds. Good results have been obtained from crossing with Large Blacks and Berkshires.

The Large White Ulster Pig.—It is white, hairless and thin skinned, with lop ears. It is suitable for the pork trade, and for rolled bacon. It has been much improved by crossing with the Large White breed.

The British Landrace.—This long-sided, long-necked, white lop-eared breed is derived from a Swedish Landrace source, and has become popular in Britain as a provider of long bacon sides.

The Large Black Pig.—Like the Welsh pig, this breed tends to have a few extra pairs of ribs in the flanks, and is thus looked upon with favour by people requiring a pig giving a good lengthy side of bacon. As the name implies, the colour is black or a blue-black, the skin being fine and soft and covered with a moderate quantity of silky hair. The head is of medium length with long thin ears inclined well over the face. There should be a good length of body, a good width across the back and good hams. Light in shoulder, jowl and offal. Objectionable features are a narrow forehead, dished nose, thick, coarse or pricked ears, coarse coat and sooty black skin. Any colour other than the characteristic blue-black is also objected to.

The Large Blacks are early maturing, hardy and docile, and well adapted to field grazing, whilst their colour affords them a natural protection from the hot rays of the sun. Crossed with a Large White boar the heavier type of bacon pig is produced, a type once used in the Midland trade. Large Blacks

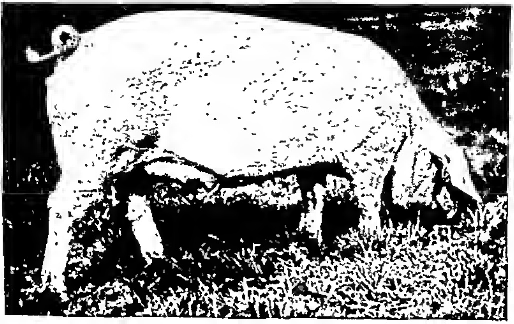


FIG 5.—A YOUNG WELSH GILT.

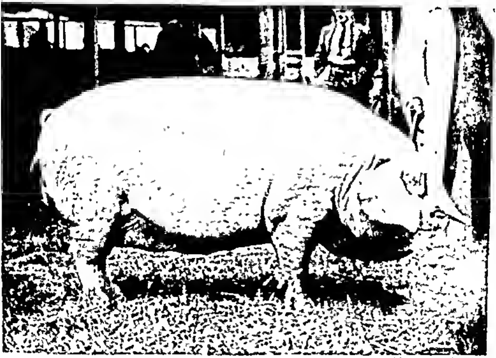


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FIG. 6.—A NATIONAL LARGE WHITE LOP-EARED SOW.

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FIG. 7.—A LARGE BLACK SOW.

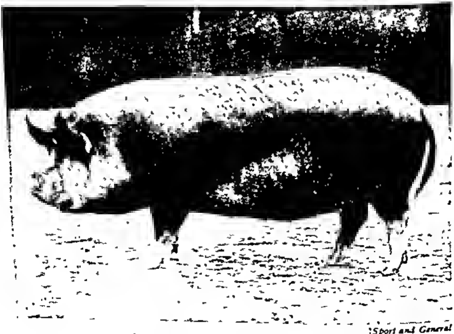

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FIG. 8.—A BERKSHIRE GILT.

have been exported to many countries including those with rather hot climates.

The Berkshire Pig.—This is one of the most widely distributed of British breeds of pigs, and, like the Large Black, its colour and hairy covering make it particularly suitable for warm climates. Berkshires are medium-sized pigs, with long, broad and level backs, thick bellies and flanks, deep hams with short legs and fine bone. Carcases yield a high

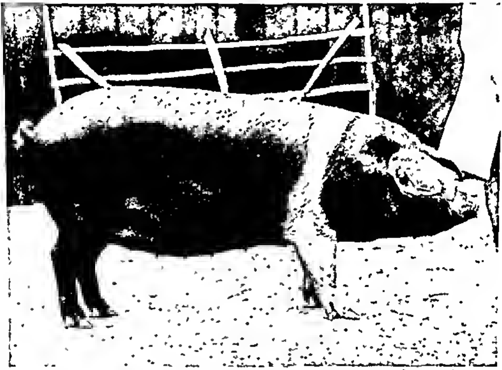

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FIG. 9.—A WESSEX SADDLEBACK GILT.

dressing percentage. It is a most useful breed for crossing and has been widely used for that purpose practically all over the world.

The Wessex Saddleback Pig.—This is a very old English breed of pig with some Neapolitan blood, and produces some prime quality pork and bacon.

Some characteristics of the breed are the presence of the "white saddle and stirrups" over the shoulders and fore-legs. The ears are pitched forward and the snout is fairly long. White at the tip of the tail or on the hind-legs is not a dis-

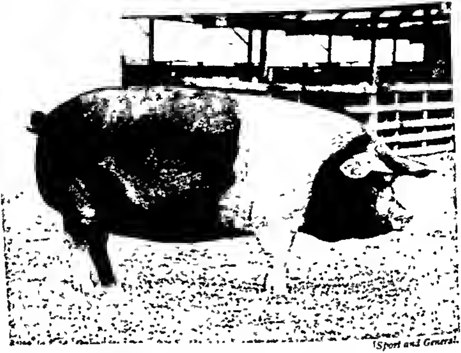

FIG. 10.—AN ESSEX SOW.

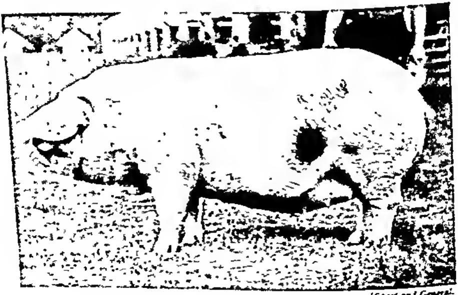

FIG. 11.—A GLOUCESTERSHIRE OLD SPOTS SOW.

qualification, but attempts are being made to breed the characteristic saddleback pig, all black except for the saddle and stirrups. The hairy covering should not be too coarse, Objectionable features are a coarse mane, crown on the back, a short turned-up snout, too heavy shoulders, wrinkled skin, inbent knees and hollow back.

The Essex Pig.—This hardy beast is indigenous to Essex and the Eastern Counties, and in appearance is not unlike the Wessex Saddleback, being black in colour with a white saddle over the shoulders, or rather a white belt, as it is not so wide as the pronounced "saddle" of the Wessex pig. Fore-legs are also white, as are the hind-legs up to the hocks. The nozzle and tip of the tail are also white. The head is of medium length and broad, the ears carried forward but not flopped.

The Gloucestershire Old Spots Pig.—This has sometimes been known as the "Cottage Pig," and is well known in the West of England, where its docility, hardiness and ability to graze and forage are appreciated.

The pig should be white with black spots or black with white spots, with long silky hair and an absence of mane bristles. The head of medium size with a slightly dished nose. Ears long and drooping, neck long and muscular, with deep sides and a bottom line inclined to droop. The belly and flank should be full and thick, the tail set high with a strong brush, hams large and well filled to the hocks. Objectionable features are a narrow head, face and nose both dished, ears thick and floppy, coarse or curly coat, bristly mane, and sandy colour. Skewbald and saddleback marking are also objections.

The Tamworth Pig.—This breed is a native of the Midland counties, and is the only sandy-red-coloured English breed. It is descended from the Old English breeds and, like the other British breeds, it has been exported.

The colour is a golden-red hair, free from black. Head long, with moderately long straight snout. Face slightly dished and wide between the ears. Ears rigid and carried forward, with a long muscular neck, a deep and wide chest, fine and slanting shoulders. The legs should be strong with some good bone, the back long and straight with long deep

sides, and a straight under-line of the belly. The hams broad and deep to the hocks; coat long, straight and fine. Objectionable features are black hairs, curly coat, very light gingery hair, coarse mane, black spots on skin, drooping ears, short turned-up snout, heavy shoulders, wrinkled skin, inbent knees, and hollowness at the back of the shoulders.

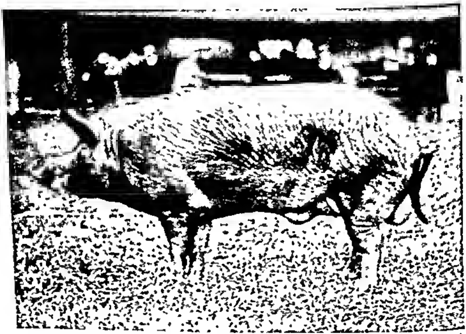

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FIG. 12—A TAMWORTH BOAR.

Breeds of Pigs in the United States of America

Many breeds in America and Canada are similar to the British breeds, having been imported and bred as a pure breed, whilst others have been crossed in accordance with market requirements. The American "Lard Hog" is a fat-producing type of pig bred for pork and lard chiefly, and in the United States it is customary to divide the pig breeds into bacon and fat types.

The bacon types are the Large Yorkshire and the Tamworth.

The fat types (whose qualifications are similar to those of the bacon type, plus the necessity of having a thick layer of

fat rather than fat interspersed with layers of lean as in the bacon pig) are as follows: The Poland-China, Berkshire Semi-fat, Duroc-Jersey, Chester White, Hampshire (which may also be classed as a bacon pig), Cheshire, Victoria, Essex, Suffolk, Middle Yorkshire, Small Yorkshire, and Mule-foot.

The Poland-China Pig.—This is one of the very fat breeds, black in colour with white on the snout, feet and tail tip. The head is short and wide, with a straight face; ears semi-drooping, and the upper third breaking over; heavy jowls; short legs with some good bone, and a broad, straight, or slightly arched back of the same width from the shoulder to the ham. Objections are a lack of size, excessive fatness, upright ears, cramped chest, depression at the back of the shoulders, and crooked legs.

The Spotted Poland-China Pig.—This breed is an offshoot of the Poland-China. It is a black-and-white pig, the legs and snout being white, with a white patch on the flank or back, or white with black patches. The face is moderately dished, ears carried forward, good bone, straight belly under-line, and the sides deep, flat, and free from wrinkles.

The Duroc-Jersey Pig.—This is one of the leading fat breeds, of a reddish colour—a cherry-red. The head is small, moderately dished, and tapering to the nose. Ears medium, pointing forward and downwards, and slightly outward; neck short, thick and deep, with moderately broad shoulders. A slightly arched, medium back, deep long sides, and hams fleshed down to the hocks. This breed is a good feeder, and possesses what are termed in the United States "good rustling qualities." Excessive fat formation and a lack of quality are objectionable features.

The Chester White Pig.—This is a white breed originating from Chester County, Pa. It is a fat type, and some bluish spots on the skin are not considered a blemish, although black hair is. The head is short and wide, with the nose slightly dished and the ears drooping somewhat. It has a deep, short neck, a broad back, slightly arched, of the same height and width at the shoulder and hams. The belly has a straight under-line and the hams are full to the hocks. The Ohio Improved Chester White is an offspring of the Chester White, but is of higher quality and somewhat more compact.

The Hampshire Pig is sometimes called the Thin Rind, and is said to originate from Hampshire, England. In appearance it closely resembles our Essex pig, having a white belt over the shoulders, the rest of the body being black in colour. In America this breed is used both for fat and bacon production.

The Middle Yorkshire Pig is a white pig resulting from a cross between the Large and Small Yorkshire, and is classed as a fat type, the Large Yorkshire being what in England is called the Large White pig, and the Middle Yorkshire corresponding somewhat to the English Middle White.

The Small Yorkshire Pig is classed as a fat type, and is one of the lightest of American pigs, weights averaging from 175 to 200 lb. at maturity. It is similar in appearance to the American Essex breed except for its white colour, but black spots on the skin are permissible. It is a compact pig, having a short head, a firm neck, and the body short but deep and symmetrical, with the hams full and plump down to the hocks. The main objections to this breed are excessive fat, small size, and slow maturity.

The Essex Pig (American) is also a small-sized black pig, with a short head and slightly disbed face, small erect ears, and a slightly arched back. Bone is of medium size and good quality. The chief American objection to the breed would appear to be its size. It is said to have originated in Essex, England, but must not be confused witb the modern English Essex breed.

The Victoria Pig.—One type of this breed originated in Indiana as a result of crossing several breeds such as the Poland-China, Berkshire, Chester White and Suffolk. It is a fat type ranging from 400 to 550 lb. at maturity. Another type originated in New York, but is now said to be almost extinct. It is not a popular breed; of a white colour, with a broad, deep, long body. The head is broad, the face somewhat dished, ears medium and semi-erect, but inclined to droop. The shoulders are inclined to be thick and heavy, making the animal appear narrow over the loins and hind-quarters.

The Cheshire Pig is classed as a middle-weight pig ranging from 400 to 600 lb. matured weight. The colour is white, but some black spots are sometimes seen. The head and face is long, dished slightly, the ears small and erect, with the back

arched and of a good width. The sides are straight and smooth, but lacking in depth. The quality is good, with fine bone. The breed originated in northern New York, where the climate is said to be not specially suitable for pig husbandry.

The Mule-foot Pig.—As the name implies, this pig has no cleft in the hoof. Its origin is not known for certain, but it has been introduced into some of the States from the Middle West. It is of a medium size, and is black in colour. The feet are small, narrow and contracted, and it is said that the breed cannot stand up to heavy feeding.

It is necessary to mention that in dealing with some American breeds the classification of fat and bacon type must be remembered, and where a pig is described as being "unsuitable" or "not popular," these terms are not used to refer to suitability for the English bacon trade nor English pork trade. Our "Wiltshire carcase" types would doubtless shock an American lard hog breeder.

The Large Yorkshire Pig used for bacon production in the United States and Canada is the Large White Yorkshire familiar as one of the world's best bacon-producing breeds. This type has already been described in dealing with British breeds, and it occupies a high place also on the American continent.

Pigs in Venezuela have been described by Morgan, who has spent many years in that country. He says that the **Venezuelan Pig** varies in colour from black, white, red (ginger), to a mixture of these colours. The present pig differs greatly from those imported by the Spaniards, and during revolutions the pig has had to fight his own battles after finding himself adrift in the wilds. It is a long-legged animal with a "razor back" and a long head almost half the length of the body. The narrow body and long legs are useful for speedy retreats when attacked by the jaguar and puma. The pigs are solipeds (mule-foot), and previous to the establishment of the meat-packing industry they had been allowed to run wild. In some districts they were considered more detrimental than beneficial, and when slaughtered were simply utilized for lard production. Since a ready market has been found the Venezuelan pig has been improved, but the majority still run wild on the plains until the maize in the enclosed cultivated area is ripe, when gaps are made in the fences to allow the pigs

to enter at night. The gaps are closed when the "ferocious" animals have entered, and they are driven to the yards for castration of the young and any that have escaped the operation on a previous occasion. They are often driven by road to the slaughter-houses, one man going in front with a wooden bowl filled with maize, and rattling it all the time so as to coax the pigs along and prevent a stampede. The pigs may have to swim wide and deep rivers *en route*, and dogs of the beagle type are used to drive the herd.

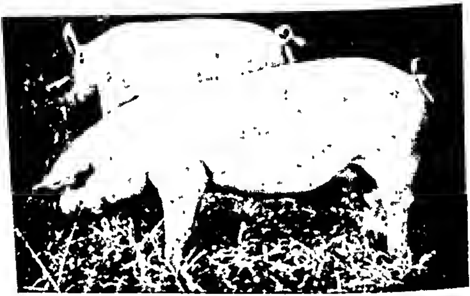

FIG. 13.—A CROSS-BRED LANDRACE–LARGE WHITE GILT, WITH A LARGE WHITE PURE-BRED GILT IN BACKGROUND; BOTH ARE GRAZING

By crossing with Duroc Jerseys, Poland-China, and Berkshire pigs from the United States, the Venezuelan pig is being steadily improved. Lard is still the chief pig product, and in spite of difficulties of transport to the packing-houses, when the pigs have been maize fed for some months prior to slaughter they dress out at about 75 per cent. of the live weight.

To return to Europe, we have the well-known **Danish Landrace Pig**, which, crossed with the Large White, produces the excellent Danish **commercial** bacon pig. In appearance the Landrace is not unlike the Welsh pig. The **Jutland** type of pig has drooping ears, with a good long body. It is reputed

[Sport and General.

Fig. 14.—A Young Swedish Landrace Boar. (Compare with Fig. 13.)

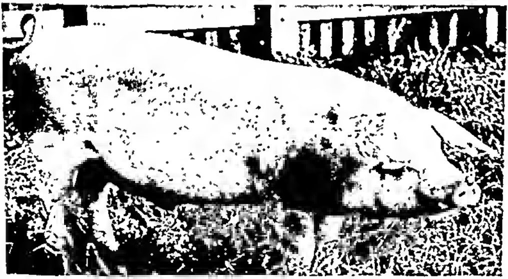

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Fig. 15.—A Young Swedish Landrace Boar.

Note the length of body, lightness of head and neck, and fleshing of hams down to hocks

to be early maturing. **The Seeland** pig, on the other hand, is similar in appearance to the Middle White, and is of a smaller type than the Jutland pig.

Germany produces some native breeds, such as:

The Angeln Saddle Pig, which is similar in appearance to the Wessex Saddleback pig of Britain.

There is the **German White,** a lop-eared pig similar to the Welsh breed, and an upright eared Large White type. **(Veredeltes Landschwein and Edelschwein.)**

The Bavarian Red-spot Pig.—This pig is white in colour in the fore-quarters and has a reddish tint in the hind-quarters. It has a reputation as a good breeder and feeder, being early maturing.

The Hanover Black-spot Pig.—The head and hind-quarters are usually black, the ears are pointed and standing out somewhat, the face is dished, the snout long, and the sides are long.

Other German pigs are the **Westphalian Pig,** which is a cross-bred Large White, and the **Baldinger Tiger Pig,** also a cross-bred native breed, crossed with our British breeds.

Italian pigs vary, and the Roman pigs are of a sandy red colour, whilst the Neapolitan pigs are spotted.

Spanish and Portuguese pigs are also of a reddish colour, and are seldom bred and cared for like the commercial pigs of other countries.

France possesses many breeds, and there has been much crossing with some British pigs. The common French pig is hardy and rather coarse. The chief breeds are the **Normandy Pig,** which includes a number of subvarieties. This is a long-snouted pig crossed with the Large White, and is a good bacon-type. The **Augeronne Pig** has a shorter nose and is of the rapid-fattening kind.

The Lorraine Pig is found in Alsace, Lorraine, the Ardennes, Flanders and Picardy, each district having its particular variety of this medium-sized pig. It is white or greyish-white in colour, often with black spots, has drooping ears, sides long and narrow.

The Limousin or **Perigordine Pig** is reared in the district from whence it takes its name, as well as in Gascony, Bayonne and the Haute Vienne Departments. This pig is a black and white saddle-back, rather coarse.

The Craonnaise Pig, also known as the Angevine, Charollaise, or Poitou breed, is also a long-bodied animal with pendant ears, rather smaller than usual in French pigs. Crosses with Large Whites and Berkshires have been numerous and successful.

The Bressane Pig, which is black with a white saddle, is found in the Dauphine region. There are various local types from black to pied in colour. It is said to be a prolific breed of good quality.

The Corse Pig is found along the Pyrenees, and is a black pig with erect ears, head large and long. It is a fine-skinned animal and rapidly fattening, producing meat which is claimed to be superior to that of any other pig.

In general, French pigs are being improved continually, and crosses with the Berkshire as well as British white breeds are popular. Although intensive rearing and fattening of pigs started somewhat later in France than it did in some other countries, there is no doubt that the French breeds are of excellent quality and offer great scope to future pig breeders.

Pigs are found in all European countries, and in Central Europe we find the **Bakong Pig,** which is also being much improved by crossing with other breeds. Its colour is greyish or black and white. **Russian and Polish pigs** are rather long in the legs, sandy coloured, with backs arched slightly. They too have been much improved and are capable of producing good long sides of bacon, much of which was imported into England from the Baltic States, Poland and Russia, prior to the World War of 1939-45. The **Chinese Pig** has already been mentioned as one of the ancestral breeds of our modern pigs. There are many types of native Chinese pigs, and all are said to have outstanding prolificacy. They farrow large litters, are good mothers, and have a high rate of survival. It is said that at weaning time the Chinese pig has more body weight than the average American breed. Sows mature sexually at an earlier age than British and American breeds. Sows farrow their first litter at about six months. On average the Chinese hog weighs one-fifth less at maturity and grows slower than occidental breeds.

Various crosses of British breeds are in regular use commercially, and most of them are designed to give the long-sided

type of pig asked for by the bacon industry. A favourite and most successful cross for this purpose is the Large White and the Welsh, the British Landrace and the Welsh, or Large White. These crosses have the distinctive merit of being white in colour and so free from any possible blemish from the grocer's angle. The black and black-and-white breeds make good bacon pigs and crosses, whilst some of the finer-haired varieties show little of the dark hair-root in the bacon rind. Unfortunately melanotic pigmentation is unpredictable and appears in the form of seedy-cut or melanomata. The crossing of a white breed with a black breed tends to produce a coarser-haired variety in which the black hair roots do show up most markedly in the rind, in spite of scalding, singeing and scraping, in the process of slaughtering and dressing. Melanomata and the seedy-cut variety are particularly prone to appear in these blue-and-white crosses. They also tend to be short-sided rather than long-sided and are not good commercial types. A more careful selection of boars and gilts should remedy this defect. The Tamworth breed can be crossed with white breeds to give a good commercial pig, and the Dorset pig is such a cross, and whilst the long snout of the Tamworth is of no commercial value, it is not a very serious blemish from the butcher's point of view.

On the whole, British breeds can be adapted to produce a first-class side of bacon, if breeders will only pay attention to the requirements of the market, and weed out by careful selection and breeding the short-sided, over-fat, heavy-shouldered kind of pigs. The Middle White and the Berkshire are unexcelled for the pork market, but here again the tendency to excess fat must be carefully controlled in the breeding.

In most countries constant work is going on to improve the breeds from a commercial angle, and in the United States of America some six new breeds are recognized from the various crosses.

There has been a tendency to overstress body length at the expense of stamina. This is seen in many Swedish Landrace pigs in Britain Out of their native longsided white lop-eared breed the Danes have produced a first-class bacon pig, and some British breeders have taken the good hams and sides of the Welsh and lop-eared breeds, with the light shoulders of

the Large White strains, to produce a baconer that can hold its own with the Landrace.

The Minnesota No. 1 Pig.—This is a red-coloured pig derived from the Landrace and American Tamworth cross, with about 48 per cent. Landrace and 52 per cent. Tamworth blood. It is a long-sided animal, with occasionally black spots on the body. It has fine legs, light shoulders, with a rather long Tamworth type snout, and ears fairly erect.

The Minnesota No. 2 Pig.—This black-and-white pig is the result of crossing the Canadian Large White Yorkshire with the American Poland-China Breed and contains 40 per cent. Large White with 60 per cent. Poland-China strain. It is bred for length of body amongst other things, but the legs are somewhat longer than those of the Minnesota No. 1 breed, and the snout is shorter. The ears are of medium size and erect. The breed performance is said to be good, and useful for crossing with other breeds.

The Hamprace or Montana No. 1 Pig.—This is black in colour and is 55 per cent. Landrace with 45 per cent. American Hampshire breed. It is about 32 per cent. inbred and has a good production record.

The Beltsville No. 1 Pig.—This pig has been developed in Maryland from 75 per cent. Danish Landrace blood and 25 per cent. Poland-China. It is a black pig with white spots, distributed rather uniformly over the body. It is an intermediate type of animal with body conformation like the Landrace. One of its distinguishing characteristics is the length of body, with slight back arch, moderate depth with good straight under-line. It is a lean rather than a fatty type, head long and narrow, with drooping ears but which do not interfere with vision. The hogs are said to dress out 80 per cent., and the average back-fat thickness is 1·58 inches in a 212 lb. (live-weight) animal.

The Beltsville No. 2 Pig.—This is a pig bred from a variety of crosses such as the Danish Landrace, the Large White Yorkshire, the Duroc and Hampshire. It has approximately 58 per cent. Danish-Yorkshire, 32 per cent. Duroc, 5 per cent. Landrace, and 5 per cent. Hampshire blood. The colour is red with a white under-line, but black spots are sometimes found. Ears are fairly short and erect. Body is of Yorkshire type

length, and is more compact than the Landrace. It is an intermediate pig. At slaughter a 213 lb. live-weight pig showed average thickness of back-fat as 1·68 inches, with a dressing percentage of 79·3.

The Maryland No. 1 Pig.—This pig carries about 62 per cent. Landrace blood and 38 per cent. American Berkshire. It is a black-and-white spotted pig intermediate in conformation between the Landrace and the U.S. Berkshire. Ears are erect or slightly drooping and medium in size. Slaughter results show a dressing percentage of about 79 per cent. The weight of the preferred cuts is said to be about 50 per cent. of the live weight. (These preferred cuts are American cuts and include Hams, Loins, Bacon, Picnic shoulders, and Shoulder butts.)

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Chapter 2

REQUIREMENTS FOR VARIOUS FUNCTIONS

PIGS are bred largely for providing pork or bacon, and breeders are usually feeders as well. In the case of breeding certain points must be kept well to the fore in deciding upon a breeding gilt. She should be healthy, and conform closely to the breed requirements, and in this respect the market in view for the "raw material" should help to decide the breed. Certain types are better suited to the pork trade than to the bacon trade, and *vice versa*, whilst first crosses make the best commercial pigs. If possible the gilt should be purchased from a reputable source where records of her ancestry are available. It is only by keeping and consulting records that prolificacy can be determined. Care should be taken to note that the gilt has from twelve to fourteen teats, and in consulting records of her ancestry the male side should not be neglected. It is said that gilts used for breeding from summer or spring litters are better than those taken from autumn and winter litters. Whilst a summer or spring-born animal certainly obtains more sunlight, fresh air, and green food to start life than the winter-born animal, and certain data from the weighing of finished bacon pigs would seem to support the idea of the spring and summer pig starting life with an advantage over the autumn and winter litters, yet too much importance must not be attached to this, as the difference is not so very pronounced.

The gilt selected for breeding should be removed from her litter mates when about twelve weeks old, and allowed plenty of exercise running around at grass or in an open-air run until about a month or three weeks before she is due to farrow. The food should be sufficient for growth, but she should not be allowed to become too fat, as such fat sows seldom have good litters either in numbers or quality. A sow which is a little on the thin side will often prove the healthier. Gilts

easily lay on fat when they are about eight or nine months old, and should be ready for service not before that age, as growth is retarded by service too early. Œstrus may be easily missed in gilts at first, and it may be a wise practice to bring the gilt to the boar daily for a time so as not to miss the period. A test devised by Aämdal and his co-workers depends on the simulation by an attendant of the behaviour of the boar at service. The test consists of the operator "riding" the sow or gilt, and animals which stand well to this test are regarded as being ready to accept the boar or to be inseminated.

The same remarks regarding the consultation of records apply also when purchasing a boar for breeding purposes, and it should be remembered that it is not so much a record of large litters born that counts, as the number of pigs per litter reared, as docility and rearing ability are as important as fecundity. It is best to use young boars for serving gilts, and the older boars for the sows.

Requirements for fattening depend upon the ultimate market of the product, either as pork or for bacon manufacture. The pork pig is the younger pig, and thus does not require to be kept and fattened for so long a period as the bacon pig; on the other hand, the prices offered for the two types may be such as to make it more profitable to keep the pigs on to bacon size than to sell them earlier as porkers.

The Pork Market.—As is the case with other meats, the demand nowadays is for small joints, and so pigs for the pork trade vary from 60 to 120 lb. dead weight. Carcases over these weights are sometimes sold as pork, such as "cutters" up to 140 lb. The general tendency in England is for the Midlands and North to take a heavier pig than the South, and this applies both for pork and bacon.

The popular demand is also for lean pork, and the day of the enormously fat show animal seems to have gone for ever, whether it be ox, sheep or pig. The seasonal variation in the consumption of pork is not so great now as it used to be, although there is still a falling off in pork consumption during the summer months. The real "pork season" begins about September and lasts until about April, reaching its climax about Christmas-time.

A dead-weight classification is as follows:

Porkers	..	..	60- 80 lb.	(3 to 4 score) dead weight.
Porkets	..	..	80-100 ,,	(4 to 5 ,,) ,, ,,
Cutters	..	..	100-140 ,,	(5 to 7 ,,) ,, ,,

A prime porker should weigh from 60 to 80 lb. dead weight, and should be the carcase of a castrated male or virgin female

[Dairy Herald.

FIG. 16.—A ROW OF PORK CARCASES.

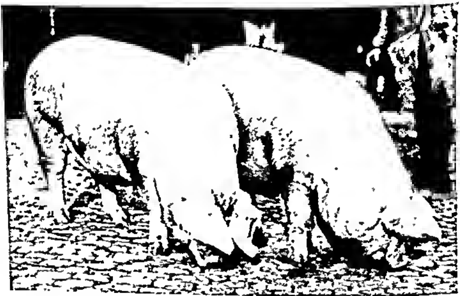
Porkers are normally "dressed" with the head on the carcase, and this row is being subjected to veterinary inspection at the abattoir before despatch to the retail butcher.

pig. The middle of the carcase from the first rib to the aitch bone must be moderately long, a good depth of loin, line of back not dished, with even back fat of not more than ½ inch and not less than ½ inch depth at any point behind the shoulder.

The shanks should be short, fine boned, and the hams well down to hocks with a thin rind devoid of skin pigmentation.

Requirements for the Bacon Trade.—The bacon industry requirements are somewhat more exacting.

There are roughly two methods of curing bacon, the dry and wet methods. The dry-curing method is the old-fashioned English farmhouse method of rubbing dry salt into the meat, and so allowing the meat to become partially dehydrated; and the wet method consisting in soaking the meat in " brine,"



[*Sport and General.*

FIG. 17.—CROSS-BRED PIGS WITH SOMEWHAT HEAVY FOREQUARTERS FOR MODERN TASTES.

afterwards drying and smoking the bacon. By the first method are produced " special cut " sides, " shoulder bellies," and " York hams." By the wet method are produced the well-known mild-cured " Wiltshire sides," where the ham or " gammon " is sold intact on the side and not as a special " York " cut.

The conformation required for the modern bacon pig is as follows: A long level back with well-sprung ribs. Flanks level and deep, with a moderately straight under-line to belly, broad hams, wide and deep to the hocks, tail being set high. Shoulders should be light and in line with the fore-legs below, and with the sides laterally The skin should be free from

wrinkles and coarseness. Light head, neck and jowl, fine bone, legs short and set wide apart, the pig standing well up on the tips of the toes.

FIG. 18.—COMMERCIAL VARIATION IN LENGTH AND FATNESS OF BACON PIGS.

These two sides are from pigs of different breeds, but of the same age, showing how attention to length of side produces more bacon rashers. The pig on the left is a Large White long-sided type, rather heavier than is usual for "Wiltshire" bacon, but typical of the "Dry cured" "Midland" bacon and ham producing industry. On the right is a "short-sided" and over-fat pig, with excessive waste, and of little use for Wiltshire, Midland or Pork trades.

It must be pointed out that good conformation does not necessarily denote good-quality meat, as that depends largely on the feeding. The live weight varies from 170 to 230 lb.

for the Wiltshire trade. A pig of 200 lb. live weight will yield on an average about 153 lb. dressed carcase weight, or 122 lb. weight available for curing in the form of two sides of bacon.

Midland trade carcases are somewhat heavier than those required for the Wiltshire trade, as this trade is in competition more with the best boxed bacon from America than with imported mild-cured bacon. Carcases up to 210 lb. and over are utilized in this trade, and they are dealt with according to the classification of lean-backed and fat-backed pigs, the former being sold as "special cut sides," which is similar to the Wiltshire side with the ham and fore-hock removed, and the fat-backed pigs being cured and sold as "shoulder bellies" in which the loin is removed.

Grading is done by measuring the back fat thickness in the split carcase at the region of the sacrum, kidney, and shoulder, and the thickness of the belly at a point opposite the upper part of the kidney, together with the length of the side from the 1st rib to the pubis. The method of grading may vary slightly from time to time, and the possibility of being able to grade the live animal by means of length, and amount of back-fat at shoulder and loin, is continually being tried out.

The dead-weight classification was from 140 to 167 lb. for the first class, 168 to 180 lb. for second class, 181 to 210 lb. for third class, and over 210 lb. dead for the fourth class. Carcases of sows, boars and "stags" are not usually cured for bacon production. Fat should set firm, white, with no softness or oiliness. White breeds are preferred, and penalties apply to certain blemishes, such as seedy-cut.

To a person unfamiliar with pigs the names given to the animals at various ages may sound somewhat strange, and it is well, therefore, to give a short explanation of some of the terms used.

The names "swine" and "hog" are often used in a collective sense for animals of the porcine species. The "boar" is the adult male pig, and "sow" the adult female pig which has borne young, every litter of young pigs being known as a "farrow." A "stag" is an adult male porcine animal that has been used for breeding purposes and afterwards castrated—*i.e.* a castrated boar. Boars after having outlived their use-

fulness for service are often castrated before being fattened for slaughter. This is done to facilitate fattening and to prevent the strong " boar " odour from tainting the flesh after slaughter, and incidentally it is also possible sometimes to get a better price for a " stag " carcase than for a " boar."

The male pig, castrated when a sucker, is often called a " hog " or " barrow," whilst the female pig that has not borne young is referred to as a " gilt," " yelt," " hilt," or " barrow," depending upon local custom. A " sucking pig," as the name implies, is an unweaned pig, whilst " stores " are immature pigs. The grading of pork pigs into " porkers," " porkets " and " cutters " has already been mentioned. Bacon pigs are graded by the trade into " sizeables," pigs from 140 to 180 lb. dead weight; " stouts," from 180 to 200 lb. dead weight; and " overweights," from 200 to 210 lb. dead weight. Carcases from 210 lb. upwards are called " pork heavies."

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Chapter 3

HOUSING AND MANAGEMENT

Many of the diseases found in pigs are due to faulty management, and in particular to overcrowding. On small farms it used to be common for one or two sows to be allowed to wander around the pastureland with their litters, returning through the ever-open sty door at intervals for feeding and sleeping. Whilst this method does not commend itself to the commercial breeder, it produces comparatively disease-free pigs. The tendency of the age is for a man to start pig keeping with a few sows, and all goes well until the additions to the breeding stock mount up, and in time he is keeping more than double the original number of animals on the same land. Up go the fattening houses, and old buildings are converted to house pigs, until the rearing and feeding becomes more and more artificial, exercise for the young is cut down to zero, and then follow those mysterious deaths in young pigs, small litters, scours, anæmia, paratyphoid, and the usual run of man-created illnesses. This is followed by frantic additions of various mineral trace-elements and vitamins to the rations, and some easing of the situation for a time, but the over-crowding remains, and the root of the cause is never touched. Housing and management are therefore of great importance in the commercial rearing of pigs.

The site chosen for housing pigs should if possible be on dry ground, with a natural slope to facilitate drainage. The sleeping quarters should be dry and warm, with adequate ventilation; the air space required per pig has been estimated at from 150 to 200 cubic feet per pig, depending upon the size and numbers of pigs housed under the one roof. The sty temperature should not be allowed to drop too low in winter. Shanks found that for pigs up to eight weeks old an optimum temperature was 80° F. and 70° F. for older pigs. The building should, if possible, face south or south-west. Some protection should be afforded, especially for the white breeds,

from the direct sun's rays in the summer. Almost any type of building can easily be adapted for pig keeping, and one of the simplest is the *ordinary cottager's pig-sty*, consisting of a small covered-in sleeping pen with an open court attached, in which is placed the feeding trough. The advantage of this type of house is its simplicity and low cost, whilst it is said to be good for young pigs especially, as they get plenty of fresh air and daylight, and tend to become hardier than pigs reared under more artificial surroundings. The disadvantages are that the pigs suffer from extremes of temperature, in that the young pigs tend to lie huddled together in the pen, and have to pass into the courtyard exposed to the weather in order to eat and exercise their body functions. This can be minimized by covering the yard or part of it during bad weather.

Yards are sometimes used for housing pigs on farms where dung is required and where large quantities of straw are available. Such a method of keeping pigs is not hygienic, but has been found convenient on some pig-farms to house weaned pigs for a time prior to passing them into the fattening houses. Loose-boxes and pens are also used for a similar purpose. The disadvantages of these forms of housing are that it is difficult to obtain an equitable temperature and a warm draught-free sleeping place, and they also require a large amount of straw, whilst the keeping of the pigs clean and dry becomes a serious problem.

The Danish or Scandinavian type of pig house seems to have evolved from practice already prevalent among large pig breeders both in America and Europe. Many breeders found that for convenience of feeding, pig hygiene and labour saving, much good could result from housing the animals under one roof. In such buildings about a dozen or more pens are built in the same hall, with a feeding passage running down the centre between lairs laid out on either side of the building. Such pens have openings into small yards on the other side of the building. At either end of such a house there is space for a heating appliance, water supply, and food mixing. The pens are raised about 2 feet from the floor of the central feeding passage. Feeding troughs are placed on either side between pen and passage, and these troughs are made of iron with a swinging gate over, so as to shut off the trough from the pigs

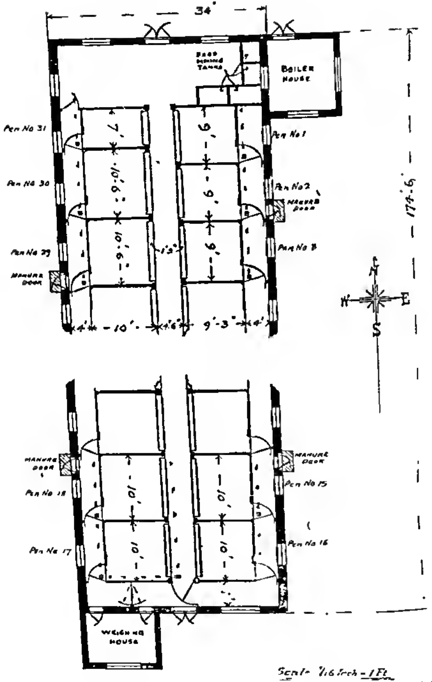

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FIG. 19.—GROUND PLAN OF DANISH TYPE FATTENING HOUSE.

when necessary. Each pen is partitioned off from its neighbour, and one corner in every feeding pen is also boarded off to act as sleeping quarters for the pigs. Doors lead from every

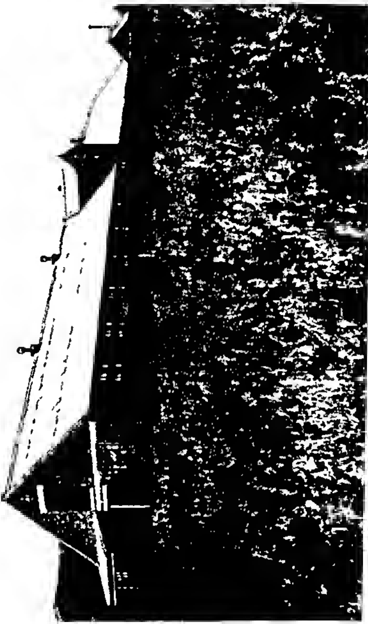


FIG. 20.—SCANDINAVIAN PIG HOUSE.

pen into a small outside yard. The feeding passage is usually about 4 feet 6 inches wide, and the pens measure 8 by 13 feet. The sleeping quarters are 6 by 6 feet.

This system has the advantage of having all the food ready

to hand under one roof, pens are easy of access for feeding and cleaning out, whilst the pigs can be kept warm, and fattened up with a minimum amount of food and time.

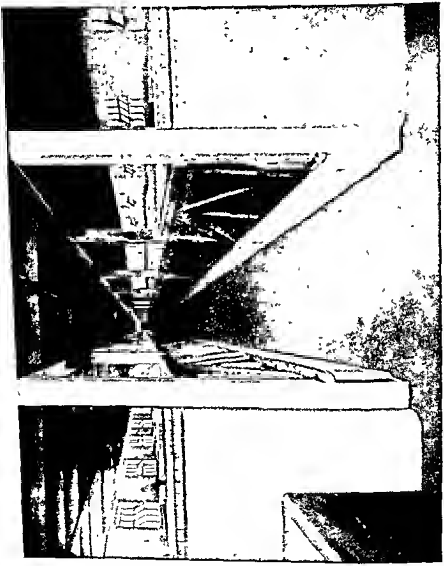


Fig. 11.—Interior of Scandinavian Pig House (showing Feeding Passage).

Such buildings can be built to accommodate large numbers of pigs, whilst in some buildings breeding pens can be built on one side of the feeding passage and fattening pens on the other side.

A more modern practice is to separate the breeding from the fattening process, and house breeding sows in a different building. This is better from the hygienic point of view in that an outbreak of disease does not thus have the same chance of spreading from the fat pigs to the sows and little pigs, or *vice versa*. The outside yard has also been dispensed with in the modern type of Danish pig house, and the building thus need only have two entrances, one at each end of the pig house, closed by double doors, sufficiently wide so that a truck or cart can be backed up and loaded or unloaded direct from the building. A small boiler house is built as a lean-to adjoining one end of the main building, and if necessary a food store can also be built conveniently at hand, if there is not sufficient space within the fattening house.

Modern floors are usually built of concrete, and immediately within the entrance is the food mixing hall with all necessary appliances, water tanks, scales, etc. Raised on either side of the wide feeding passage are the pig pens, whose floors are about 2 feet above that of the passage. The pen partitions may be built of wood or concrete, and at the rear of each pen is a dung passage running along the wall to the far end of the house. Each pen partition is continued across this passage by means of a door of equal height, so that when all the doors on one side are open, they fall back against the pen, allowing a free passage right down the length of the building. This facilitates cleaning out, and moving pigs from one pen to another, as well as a weekly move down to the weighing room at the far end. Thus all excreta can be moved out through the doors and disposed of without any contact with the food mixing room.

The weighing house at the extreme end of the Danish house should contain a weighing machine capable of holding each individual pig. The weighing platform is fenced in, with doors at either end, so that a pig can be driven in on one side and out at the other after being weighed. Pigs enter the weighing room directly from the passage at the rear of the pens, the doors being made to swing right or left. Pigs leave the weighing room by an exit which allows the animals to move into a space between the last pen and the weighing room. When all the pigs in one pen have been weighed, they can then be moved

back along the passage to their own pen. These Scandinavian type buildings thus facilitate the proper recording of pig weights, and small boards can be fixed over each pen giving

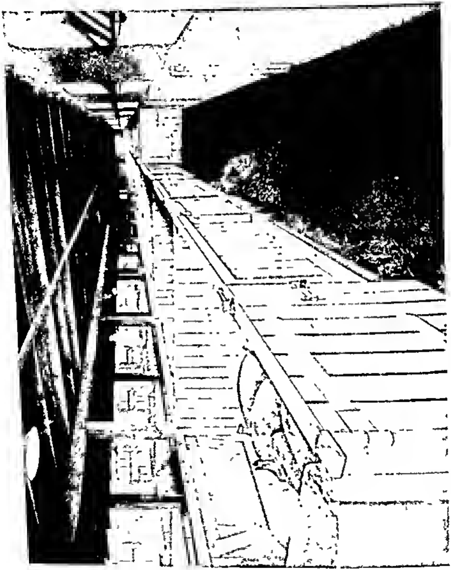
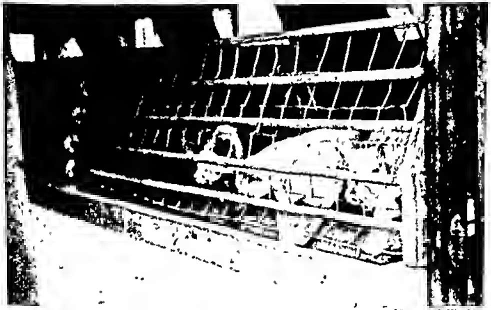


FIG. 22.—INTERIOR OF SCANDINAVIAN PIG HOUSE (SHOWING MANURE PASSAGE).

the number of pigs in the pen, date of birth, with increase in weight, as well as any other particulars required.

Danish pig houses may be constructed of wood, brick or concrete, and in some such houses a ceiling may be fitted, with a loft above to house straw. This may help to keep the

building warm, but it adds considerably to the difficulties of proper ventilation, the latter being of paramount importance where hundreds of pigs are housed continuously under one roof under conditions which are after all artificial. Swine pneumonia and swine erysipelas are some of the chief bugbears encountered in such houses where ventilation is not efficient. A building with no loft above is therefore preferable to one with ceiling and loft. Ventilation is by means of Sheringham valve windows, which are better than the "hit-and-miss" type, as the latter are often neglected and tend to become



[Farmers' Weekly]

FIG. 23.—INTERIOR OF FATTENING HOUSE OF THE SCANDINAVIAN TYPE (BOULTON AND PAUL).

fixed in a permanently "closed" or "open" position in all weathers. Where a ceiling exists with a loft above, it has been found that ventilation can be bettered by means of ventilating shafts running from the roof to within a foot of the pen floor. If the bottom of the shaft is raised above this height there is a tendency for a down draught on to the pigs' backs. The first pens on either side of the feeding passage, immediately within the entrance to the building, as well as the last two pens at the far end, require especial care in the height of their partitions. If the wide doors at either end of the house are left open, as they often are, especially in the

summer, a draught may be created, and experience has indicated that there is some truth in the contention of many pig attendants that most of the pneumonia cases tend to come from the pens situated at the extreme ends of the building. The partitions between the pens are usually from about 3 feet 6 inches to 4 feet in height. Where pneumonia is prevalent, it will be found advantageous to raise the partitions at both ends of the buildings nearest to the doors to a height of about 6 feet or so. This helps in preventing a down draught on to

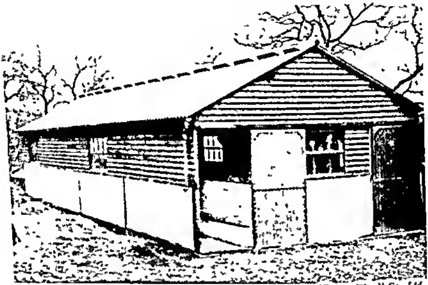


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FIG. 24.—A SMALL TYPE OF FATTENING HOUSE.

these pens. Where suitable circumstances prevail, it might be possible to maintain proper ventilation and humidity by the use of variable-controlled extraction fans installed in the ceilings or roofs of pig houses.

The Scandinavian type of house has also been used for breeding sows and litters. Construction may be of timber, brick and concrete. If such houses are to be used for the farrowing sow the building is usually wider than the fattening house. This gives room for larger pens, and a wider feeding passage in the middle. There is no ceiling with loft above, nor is there a passage at the side of the house and behind each pen. The outside walls have small openings sufficiently large

to allow the little pigs to run in and out into a small "yard" or enclosed space on the outside. This little yard runs the length of the house on either side and is partitioned off at each pen length to avoid getting the piglets mixed up. Such yards may only be about 3 feet wide and 8 feet long. The floors are of bare earth, walls of timber, brick or concrete, the outside wall being about 2½ to 3 feet high. They are roofed over, in the form of a "lean-to," against the main building, the roof rising to about 4 feet where it is hinged against the farrowing house wall. The roof has some glass panes to let in the light.

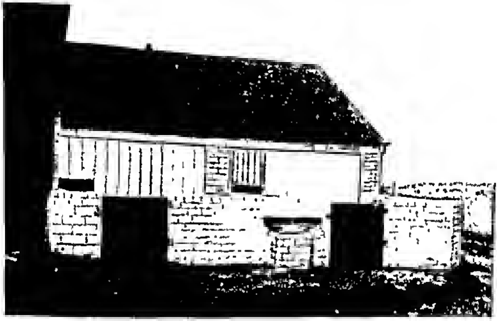

FIG. 25.—OLD TYPE STY WITH YARD.

These buildings are intended for the intensive rearing of swine, providing plenty of warmth and dryness, with some access to an earth-paved yard of very limited size. The disadvantage of such a building is that it cuts the little pig off from sunshine and fresh air, except what it can obtain when the attendant allows the roof of the little yard to remain open during suitable weather. The sow feeds and sleeps in the one pen, so that the floor is soon wet. The pig is normally a clean animal, in spite of popular opinion to the contrary, and in the Scandinavian type of fattening houses pigs will soon develop the habit of using the dung passage at the rear of their pens, and will keep the sleeping pen fairly clean.

Such houses are not suitable for the sow and litter, unless the young stock have access to some pasture-land. Attempts to rear pigs in houses of the type described in the foregoing paragraph invariably lead to deficiency troubles, notably pig anæmia, scour, and even paratyphoid. Attempts to treat such conditions by palliatives such as iron, green food, ashes, and the other well-known remedies only give moderate satisfaction, but when little pigs reared under such conditions are allowed out to some pasture-land, even if it is only for a few hours during sunny weather, the improvement in their condition is most marked. This only serves to emphasize that the rearing of little swine like hot-house plants does not pay in the long run. Whilst Danish houses may thus be very useful and effective for fattening stock, they are not the same success for intensive rearing of unweaned swine, unless there is available ready access to the land. The fat pig needs to be deprived of exercise for fattening purposes, but the youngster a few weeks old needs exercise, and in the building of this kind of house for farrowing sows there is a danger that this limitation of freedom for the young pig is being carried too far.

There are many modifications of the Scandinavian pig house, and of these the so-called Dykelands house deserves mentioning. This type of building was developed in Scotland and its chief distinguishing feature is that the dung passage lies between the sleeping pen and the feeding trough. The sleeping pens thus lie against the side walls of the building, and so allow of a lowering of the height of the walls and roof, increased warmth being obtained by sacrificing cubic air space. The drainage must be towards the feeding trough, and in a crowded house of this kind the atmosphere soon becomes polluted. Care must therefore be taken not to overcrowd the building with pigs. Another modification is to use a type of Scandinavian house, but to keep the pigs warm with deep straw beds which are not cleaned out except about once a month. Both modifications are designed to save artificially heating the pig houses, and neither system can be described as particularly hygienic.

There is a school of thought which insists that pigs can be successfully reared to bacon weight indoors, without the young animals ever being allowed out at pasture, and in order

further to conserve animal energy as well as building space, a still more intensive form of pig rearing has been tried. This is a kind of "battery system" of bringing up piglets. The young animals are packed into as small a space as is possible, without being downright cruel, into box-like pens built one above the other, almost like the poultry battery system. These unnatural methods of rearing pigs can succeed for a short time, but they generally end in sapping the vitality of the animals and such deficiency conditions as anæmia, rickets and scours become rife.

Greater freedom from disease is experienced where pigs spend part of their lives out of doors on some good pasture-land. Any old meadow or park land is just not good enough, as pigs can graze like other animals, but they require a good ley with some growth in it. If pigs are turned out on good land, then they are usually too busy grazing to bother about rooting. If the land is extensively rooted up, then it is a good sign that the pigs on it need moving to fresh pastures. Rings inserted in the snout are used to prevent rooting, and these rings are cheap and plentiful. A special kind of pincer is supplied by the instrument makers for inserting the rings in the pig's snout. Some people are not satisfied with this method of ringing a pig, and one can find all sorts of weird contraptions such as copper wire, curved horse-shoe nails, and other equally cruel and revolting methods used.

Various types of huts and "arks" are available for sow and pigs, some being constructed of timber and others of metal, but all equally effective. They can be moved from used pasture to fresh sites, as some are built on wheels and others on skids, so that horse or tractor power can move them to the required site. This is an advantage over permanent styes. For the nursing sow and her pigs warmth is essential inside these huts or arks, and various methods can be adopted to prevent draughts, the simplest of all being to fix a curtain of sacking over the open doorway. Where necessary a short passage with a sack curtain at either end can be fixed to the hut entrance. Apart from huts and arks temporary shelters can be built with straw bales and chestnut paling. The chief thing to bear in mind is that the pigs must have warm, dry, draught-free sleeping quarters. Cold, wet and comfortless sleeping quarters not only retard

growth, but are an invitation to pneumonia and other diseases. Temperature fluctuations must be kept within narrow limits.

Creep feeds can be provided in hoppers for the little pigs outdoors, and a railed off part of the pen can be used if they are being reared indoors. Pigs running around on good pasture-land will obtain a supply of vitamins and minerals to make up for any possible deficiency there may be in the sow's milk or in the ration. As a rule, sows with a reputation for docility make good mothers. The lop-eared breeds, being unable to see very far owing to the ear-flaps coming down over the eyes, tend to be less inclined to want to wander away from their compounds than do their short-eared and upright-eared sisters. The latter are so alert that if there is a weak spot or hole in the fence, they will soon see it and will be through to investigate what is beyond in no time. Fencing for compounds needs to be strong and firmly fixed, as pigs can soon have it down through rubbing constantly, or a very vivacious sow, once she gets her snout well under a fence, can soon clear a gap for herself. There is tremendous strength in the sow's musculature.

Electric fences are very useful and the animals soon get to know and avoid them. Care should be taken to adjust the height of the wire to suit the kind of pigs being kept in the particular compound. Whilst no harm appears to be done to the pregnant sow by touching a " live " fence, it is not advisable to use it for such animals, as sudden shocks are not good for pregnancy. In moving pigs from a compound fenced with electric wires a few hurdles can be used to form a gap in the fence and to allow the animals to walk through. The pigs will not graze under the electric fence, and where the grass is long, even after the wire has been removed, they will hesitate before grazing there.

By means of portable structures the pigs can be kept to fresh ground until they are ready for the final fattening up. Huts and compounds can be arranged in a circular or semi-circular fashion, with feeding troughs to the centre, so as to make feeding easier for the pig attendant. The latter will need a hut for his implements, hot-water supply, marking kit, first-aid kit, record books, and the various other things which every good pig-man keeps on hand. There are some good

portable weighing scales available nowadays, and all these tools need to be housed close at hand to the pigs, so that a good type of hut, like a shepherd's hut, would have to be provided for the pig man. Food stores, food mixing, water supply, and roadways all need to be thought out before deciding upon the

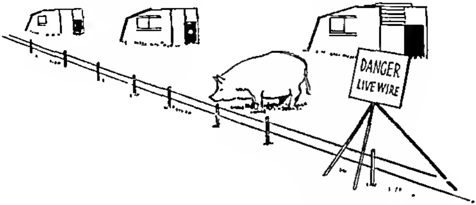

FIG. 26.—THE ELECTRIC FENCE IN USE.

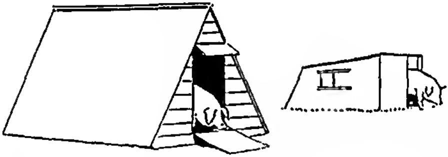

FIG. 27.—TWO TYPES OF HUTS SUITABLE FOR USE WITH ELECTRIC FENCES.

site for the huts and compounds. All this adds to the cost of keeping pigs under the outdoor system, and shows why the indoor method is often favoured.

A combination of the two, where the weaners are taken indoors for the final feeding, works very well, as the young pigs, having had the early weeks of their lives out of doors with the sow, are now sufficiently fortified to assimilate the fattening ration gradually, and last out the remainder of their short lives to slaughter weight without succumbing to any disease, so long as they are under normal common-sense management.

It is a great mistake to buy in-pigs from an open market.

That way lies disaster, as open auction markets are some of the best and most efficient means of spreading contagious diseases amongst animals. Some people do no rearing of pigs on their own farms, but rely upon filling their fattening houses with stores bought in open auction. These are the farms where swine fever often makes its appearance. There are plenty of reliable breeders from whom potential pigkeepers can purchase stock and obtain reliable advice, and it is a pity that more attention is not paid to quality. Most countries have Associations of pig breeders who are only too willing to help the beginner with sound advice.

In-pig sows and gilts are best kept in the open, in as nearly natural a state as possible. It is usual to restrict their movements by fencing, but the essential feature is quiet exercise. The land used may be grass, woodland, or arable, each possessing certain attractive features. Healthy grass properly manured and constantly grazed forms a good diet for breeding animals. If the grass fulfils the sow's needs there will be little temptation for her to root up the land. Similar considerations apply to arable crops. In woodlands, the tree shade is a possible asset, but pig manure is wasted, whilst the edible herbage available is likely to be poor in quality and quantity. Fruit orchards are also suitable for running sows. There are no hard-and-fast rules for housing the pregnant sow; shelters can be constructed of hurdles and bracken.

Whatever method is adopted for housing pigs, it must be realized that the animal needs dryness, warmth and comfort in the sleeping quarters. It cannot be over-emphasized that a down-draught on the pigs' sleeping quarters is one of the main predisposing causes of pneumonia. The pig is not allowed to lead a natural life, it is artificially reared and fed almost throughout the whole of its short life, and the idea that any draughty old place will do for housing pigs is responsible more than anything else for the widespread nature of pig pneumonia. A breeder who wonders why his young pigs are not thriving would do well to study the sleeping quarters of his animals before taking any drastic measures. The conditions the animal has to live under during the hours of daylight may vary, but given a warm, dry sleeping pen with plenty of bedding and no down-draught, it is surprising how pigs will thrive.

The use of infra-red lamps on piglets has shown how much the pig appreciates warmth.

Pigs require plenty of fresh air, and it is recommended that the standard degree of purity for animal houses should not be lower than 96·7 per cent.—*i.e.* the air in buildings should not contain more than 3·3 per cent. of air once breathed. Pigs require an hourly supply of fresh air at the following rate:

$$\frac{46 \times 100}{3 \cdot 3} = 1{,}394 \text{ cubic feet.}$$

For practical purposes Linton gives 1,000 cubic feet of fresh air per hour as the requirement for pigs, and the approximate cubic space required per animal in order to keep the condition of the air within the standard of purity desirable, and allowing for a complete change of air to be effected within the building five times during the hour, as 200 cubic feet.

For a sow with a litter of pigs approximately 100 square feet is a suitable floor space, and such a pen will hold three or four fattening pigs according to their size. Pens should be about 12 feet long by 8 feet wide, with a feeding passage 7 feet wide down the centre, and pens on either side; this gives the building an inside width of 23 feet. Other authorities recommend huts to house about six fattening pigs of about 200 lb. weight to be about 10 by 8 feet, and breeding pens 12 by 12 feet, with a farrowing rail reducing the indoor dimensions of floor space for the sow to 10 by 10 feet. For outdoor folding, huts from 9 by 7 feet up to 12 by 10 feet are recommended as being suitable for sows.

Excellent work on the subject of the climate of pig accommodation has been published in recent years by Dr. D. W. B. Sainsbury of the University of Cambridge (England). His scientific investigations have enabled him to lay down very precise requirements in connection with the size of pig houses, ventilation, and systems of indoor management (1955).

Under the folding system the sows are farrowed indoors and transferred to folding huts a week or fortnight after farrowing. The huts are provided with wheels, and can thus be moved to fresh ground every few days. There are various modifications of this method, depending on the land available. In some cases the huts are semi-permanent, and are fixed in

small compounds. The sows farrow in such huts and rear the young pigs up to the time of weaning, when the youngsters are transferred to yards or directly into fattening houses, whilst the sow is returned to the breeding farm ready for further service. Unless about half the compounds can be kept empty at a time, there is danger of the land becoming "pig-sick," deficient in green stuff, etc., manifested by a crop of small litters, dead piglets, and general unthriftiness This is a grave fault of the Waldmann system of pig rearing, where the huts are permanent in sandy yards. Pigs need

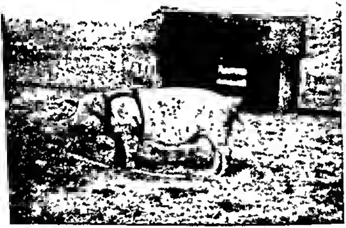

FIG. 28.—THE TETHERING SYSTEM.
The sow is tethered to the farrowing hut by shoulder harness and chain.

green pasture-land or its nearest equivalent if they are to be reared as healthy stock. There is already too much swine fever, paratyphoid, anæmia, scours and erysipelas among pigs, without placing young piglets on land which by its very nature can easily become denuded of its essential mineral and other elements.

Another modification of this system is the tethering of the sow by means of a harness fastened over the shoulders to a length of chain which in turn is fixed to an iron bar driven into the ground. This allows the sow a certain amount of liberty whilst protecting the ground from too much damage.

Huts may also be provided with movable hurdles which can be moved to each hut as required, and the land afterwards ploughed up and sown with barley or some green crop.

In farrowing houses, pig creeps should be fitted in one corner of the sleeping pen or in the compound in the case of pigs having an outdoor run, so as to encourage the little pigs to commence eating dry food as soon as possible. It will be found that the little pigs will take advantage of these facilities before they are four weeks old.

The Boar.—The boar should be selected carefully, and purchased from a reputable breeder, who takes care to start his boar selection whilst the animal is still in the unweaned stage. If the sow has the necessary characteristics of the breed, and is a sound commercial proposition, a prolific breeder and a good mother, then one or two of her male progeny will be selected for rearing entire, and will not be castrated. They should be examined to see there are no blemishes, and that both testicles are palpable in the scrotum. The body should be of good length, shoulders light, and the little animal perfectly fit. After weaning the young boars should be placed together, and watched as they grow up. They should be allowed out on to some good pasture so that their mineral and vitamin requirements are not neglected. When they are about 18 weeks old they should be examined again to weed out those with bad points. These should be subjected to castration by a veterinary surgeon, as the operation in a pig of this age is no longer the quick one it is in the unweaned pig, but a surgical operation requiring care and skill. Only the best pigs should be kept.

A young boar does not come into his full maturity for service until he is about eighteen months old, and he should be started off with a few gilts. Where more than twenty-five to thirty sows are kept there should be more than one boar. The practice of keeping boars indoors during almost the whole of their adult lives, and dependent upon rations which may be lacking in some vital element, is undoubtedly responsible for much sterility in these animals.

Care should be taken to see that the boar gets plenty of exercise and green food. It is often the custom to allow the boar to run with the sows, but this is not a very good system, as the boar may soon exhaust himself and may

damage the sows by pommelling them in the flanks with his snout, and the breeder may wonder later on why his sows farrow some dead pigs. Over-feeding of the boar makes him lethargic. A young boar should not be overworked, and the same remark applies to adult boars. Practical experience has shown that an adult boar can without detriment serve up to twenty sows a month in single service.

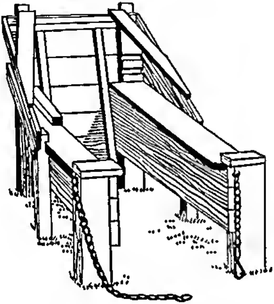

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FIG. 29.—A TYPE OF HOME-MADE SERVICE CRATE.

This is useful where the boar is too heavy for the sow. It can also be used as "stocks" to restrain a sow or boar for minor operations.

Except in extreme cases, such as when the spermatozoa are weak, the boar has little influence on the size of the litter. A boar is selected from a large litter because he transmits this desirable characteristic of prolificacy to his daughters. Should the sow fail to conceive, careful consideration must be given to this trouble which has been known to occur often in some herds. It is necessary to ascertain whether the trouble is isolated or widespread. If several sows turn habitually, no matter what boar is used, it is possible that neither sows nor boar is to blame. Specific causes of sterility are not usually widespread. In many cases it is feeding that has most to do

with capacity to breed. Here lime and iodine play an important part, whilst vitamin E may be lacking if boars and sows get no runs on pasture. Accurate records should be kept of the boar service, as well as of each individual sow. These records should provide information as to the average number of services per 100 farrows, as well as the average interval in days between successive farrows (which should be about 180 days).

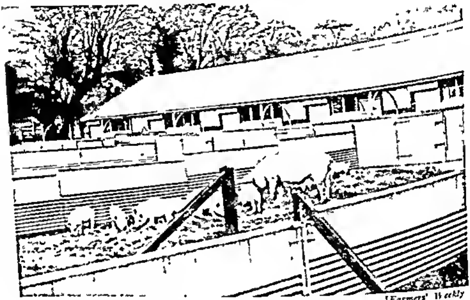
Artificial Insemination may be used, where the semen is collected by an artificial vagina. Boar semen is usually bulky, but with a comparatively low sperm density. In adult boars one ejaculation varies from 100 to 500 m.l, with an average of around 200 ml., concentration of sperm being about 100,000 per mm^3. The process may take from 3 to 20 minutes to complete, the great bulk of the ejaculate being composed of the accessory gland secretions: seminal vesicles 20 per cent., Cowper's glands 15 per cent., prostatic and urethral glands 62 per cent., with epididymus 3 per cent. Boars can be used two or three times a week.

In natural insemination the boar ejects a large amount of semen into the uterus directly. At the end of the service, a gelatinous plug seals the cervix. Since oestrus may last for 2 to 4 days in the sow, she may be mated more than once during that time. In artificial insemination, the gelatinous material is removed from the semen beforehand, so that no plug is formed in the cervix. Ovulation in the sow takes place between 18 and 36 hours after the onset of the heat period (with some variation in breeds and types). It is known that if a sow is mated on the first day with a white boar, and with a black boar on the second day, the little pigs will be black. If she is mated on the second day with a white boar, and with a black boar on the third day, in the majority of cases the little pigs will be white.

The Sow.—The remarks which apply to the selection of the boars are also applicable to the sows. They should be selected when young from a good proven strain showing no lack of fecundity or any abnormalities in progeny. A good length of body, lightness of forequarters, tail well set up on hams which should be well fleshed down to hocks, are all desirable points. The number of drills or teats must be adequate, as it is of no

use selecting a young gilt possessing all the desirable points but with only ten teats. Nothing under 12 teats should be considered, unless one is looking forward to small litters.

The young gilts should be put together after weaning and allowed out on good leys with a little dry-supplement feeding in addition where necessary. They should be carefully inspected again before reaching maturity, and any which have developed undesirable characteristics weeded out of the herd. Allowing the gilts ample scope for exercise at pasture will help to prevent over-fatness which can lead to sterility, and it will



[Farmers' Weekly

FIG. 30.—EXTERIOR OF A WILMOT FARROWING HOUSE SHOWING MOVABLE RUNS.

ensure that the animals are getting the vitamins, sunlight and fresh air so necessary for a healthy body.

Another point that might well be worth mentioning is the necessity of the proper handling of the gilts as they grow up to maturity. A good pigman, like a good groom or stockman, is quiet and efficient at his job. He lets the animals get accustomed to him, so that they get to know his "smell," and have no fear of sudden punishment in the form of a blow with a stick, or a kick from a heavy hobnailed boot. Animals handled humanely usually make good mothers, and when any

minor operation has to be performed on them later on, they need little or no restraint beyond the presence of the accustomed pigman. The stockman who handles his animals gently, using his hands and voice, is amply repaid in having gained the confidence of his charges early in their lives. What a contrast it is to visit a farm where the attendant cannot enter a pen without a stick in one hand, and a constant prodding and belabouring of a penful of frightened animals. In these days of mechanization town-born animal drovers in particular seem to have a fixed idea that animals cannot be handled without a big stick with which to hammer the hide off whatever animals are placed in their temporary charge. The quiet, confident approach is the only way with pigs as with other farm animals.

It is recommended that young gilts coming into œstrus for the first time should be brought to the boar fairly often, so as not to miss the first service. The swelling and reddening of the vulva, mounting and worrying other pigs, standing steady with ears forward, and frequent micturition, with a tendency to a falling off in appetite, are all indications of œstrus. Too early service tends to retard growth in gilts, and about nine months seems to be a practical time to start breeding from a good-sized gilt. The period of œstrus lasts for about three days, or less in some cases, and in non-pregnant sows it tends to reappear every nine to twelve days or a month. Satisfactory service is best obtained at or towards the end of the period rather than in the early stages. The act of copulation takes about ten minutes, and the period of gestation in the sow is from 114 to 117 days. Within a fortnight or three weeks of boar service the tiny embryos will have been formed in the uterus, and in about 50 days the embryos will be about 80 mm. ($3\frac{1}{4}$ inches) long from their large foreheads to the root of the tail. At birth they will vary from 8 to 10 inches in length, and will be covered with fine silky short hair—the future hair and bristles so valuable for furniture and other padding.

As overfatness and a " show condition " is a frequent cause of sterility, pregnant sows should be allowed plenty of exercise and access to green food, but should not be allowed to become too fat. About a week or a fortnight before the date of farrowing the sow should be placed in the farrowing pen at night and

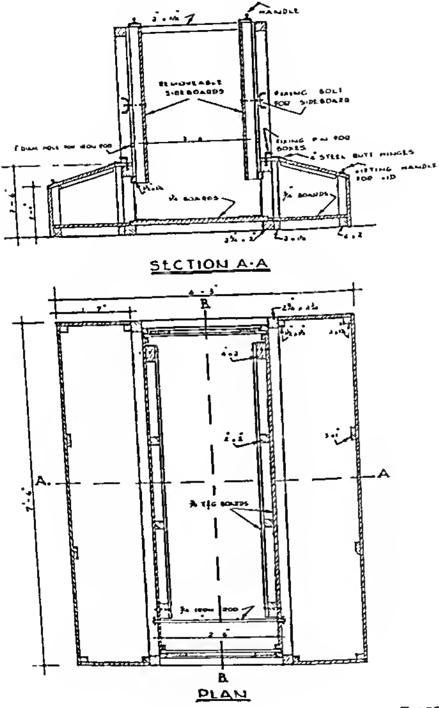
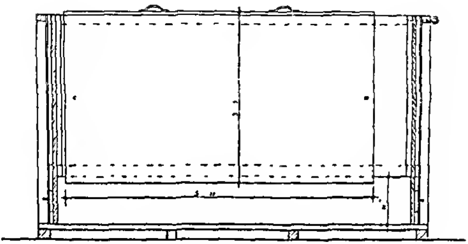


FIG. 31.—FARROWING



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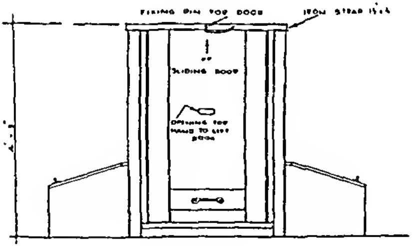

END VIEW.

CRATE (SHANKS). [*Veterinary Record.*

handled by the attendant who will have to look after her during the farrowing period.

There are several methods of accommodation at this time, one being to use a pen or sty where the sow may remain until farrowing is well over and even until the pigs are weaned. This method has serious disadvantages, as the desire and need

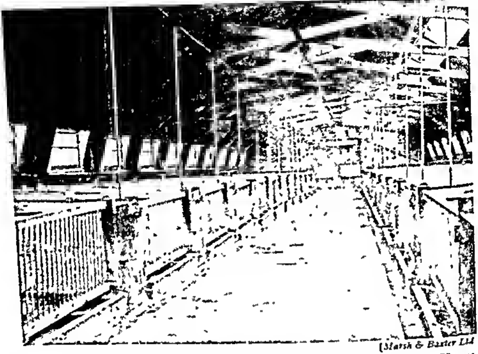

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FIG. 32.—A TWENTY-EIGHT PEN FARROWING HOUSE, INTERIOR VIEW.

The pens on the right have small openings from each pen into a tiny outside covered yard, to provide exercise for the piglets. The pipes running down into each pen provide water for automatic troughs as used in cowsheds The whole building can be heated in winter.

for exercise is even more important than ever now, and whilst the sow may be shut in for a few days before and after farrowing, she ought to be allowed out again as soon as possible. The young pigs require fresh air, sunshine and exercise, especially if they are to be confined for the whole of their post-weaning existence. In the open-air method the sow has a run of about a tenth of an acre, with the usual hut or shelter. Here her exercise and grazing proceed without interruption,

and she can in due course take out her litter. The run may have a few shady trees or bushes. Wind and sun shields may be improvised by means of hurdles with bracken or straw. A creep for the young pigs can also be made to contain a small trough out of the mother's reach.

A farrowing crate (Fig. 31) will be found most useful, as it allows just sufficient room for the sow, and the little pigs can

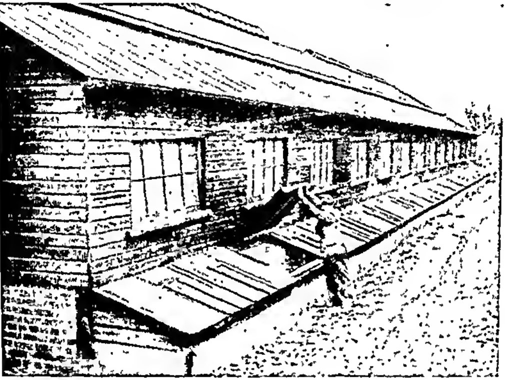

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FIG. 33.—AN EXTERIOR VIEW OF THE TWENTY-EIGHT PEN FARROWING HOUSE SHOWING THE SMALL "YARDS" RUNNING DOWN THE ONE SIDE.

The cover over one such "yard" is lifted to show method of access from the outside of the building.

be protected as soon as they are born. In recommending such crates Shanks adds that certain arrangements are usually added to the farrowing crate to adjust it to the size of the sow, so that she is able to turn round when inside. Wooden bolsters may be screwed or bolted to the sides at the middle to make the crate narrower, whilst slots or holes may be made in the sides about 1 foot 9 inches from the floor and a similar distance from the end, into which a metal or wooden bar can

be inserted to make the sow's compartment shorter if necessary. A sow can soon be trained to enter such a crate, and it has the advantage of being warmer in winter than an ordinary pen. The crate can be easily housed in a shed or pen and should be a feature of every pig farm, as it will prove not only useful for the farrowing sow, but can be adapted as "stocks" to hold recalcitrant sows and boars for the various little operations which are sometimes necessary on such farms. It should

FIG. 34.—WARMTH FOR THE NEWLY BORN.
Part of farrowing pen fenced off, showing young pigs asleep under radiant heat rays.

be hardly necessary to add that the crate must be thoroughly washed out and disinfected after use.

Many people dislike the farrowing crate, and prefer to allow the sows to farrow down in huts within compounds, or in the Scandinavian type of breeding house, where the farrowing pens run down one side of the building, and are separated from the rearing pens by a wide feeding passage. The rearing pens have a small opening in the outer wall through which the little pigs can run into a tiny earth-floor yard. These yards are fitted with glass roofs which can be raised on a hinge for the purpose of cleaning out, and placing creep feeds in position. These

buildings are costly and are not to be recommended. They are built with the intention of keeping little pigs indoors from birth to fattening in a cold climate and are usually quite useful sources of anæmia and scour, as one would expect under such hot-house conditions.

Farrowing rails are usually fitted to the pens, and if space permits one side of the pen can be railed off about $2\frac{1}{2}$ feet from the side. One half of the railed-off portion can house the creep feed later on, and the other half can hold straw into which the young pigs will burrow in due course for warmth and comfort. Another useful method is to provide artificial heat in the form

FIG. 35.—FENCED-OFF PORTION OF FARROWING PEN, WITH STRAW TO PROVIDE WARMTH FOR YOUNG PIGS, INSTEAD OF USING ELECTRIC HEAT. A canvas strip hanging from bottom rail would be an improvement.

of an electric or mild heat bulb behind the railed-off portion of the pen. The rails should be sufficiently strong to prevent the sow breaking them down, and the bottom rail should be about 9 inches from the floor, so as to allow the piglets to run underneath. It has been found from experience that young pigs when they have suckled migrate automatically to the warmest corner of the pen, and there huddle together getting their quota of sleep which is so essential for healthy growth. The provision of some artificial heat for them to lie under also ensures that they are not wandering about the sow's feet and are in no danger of being trampled or laid upon. The provision

adherent to the endometrium, so that the passage of the foetus through the uterine horn is not impeded. Parry suggests that the shedding of the placental membranes is helped by the loosening of the chorionic attachment owing to the partial collapse of the anchoring villi when the capillary blood pressure within them is reduced with the cutting of the umbilical cord. The fœtuses are not necessarily born in the same order of their position in the uterine horn during pregnancy, nor are they born in the order of their location in the left or right horn of the uterus.

In the case of breech presentations, the passing of a dead fœtus, or an evil-smelling brownish discharge from the vulva, and the passing of portions of putrid membranes, the act of farrowing may be completely suspended. In such cases the surgeon who has rather small hands may find it an advantage. The sow should be handled gently and the clean hand and arm covered with some antiseptic grease gently inserted into the vagina. It may be possible for a small person to insert the hand right down into the uterus and assist in the delivery of the fœtus. Owing to the size and structure of the porcine uterus it may prove impossible to turn a breech presentation into a normal one, and the fœtus should be carefully removed breech first in such cases. The uterus is comparatively thin in sows, and any attempt to turn a breech case *in situ* may lead to a rupture of the uterine wall. The injection of an antiseptic lubricant into the vagina may have to be resorted to in cases where the fœtus has been dead for some time. Failing manipulation by hand, a veterinary surgeon's services are required.

Following a difficult farrowing it may be found advisable to wash out the uterus and insert a pessary, whilst tonics may be administered to the sow. Where the sow passes a dead fœtus and there is a complete suspension of labour, a putrid discharge from the vagina often containing portions of dried-up and putrid membrane, it may be impossible to reach the remaining little pigs either by hand or forceps, especially if the sow is on the big side with a very pendulous abdomen. In such a case pituitary injections are of little value. All the little pigs may be dead, the uterus quite dry inside, or there may be a twist in the uterus itself. In such a case

Cæsarean section may have to be resorted to. The economic question arises at this stage, as it does in many veterinary operations, and it may be advisable for the owner to have the animal slaughtered in an endeavour to preserve the carcase for food, rather than to risk an operation, especially as the owner is hardly likely to risk sending the sow for service again. The operation is done on the right flank.

In the case of a retained placenta, a hypodermic injection of pituitrin will often effect expulsion of the membranes. This can be assisted by laxative feeding, exercise, and if possible manual removal by the veterinary surgeon.

The little pigs should be carefully examined for any malformations, and that the number born is within the ability of the sow's rearing capacity—*i.e.* if the number in the litter is greater than the number of teats the mother has, then it may be well to transfer the extra pigs to another sow who may have fewer pigs than teats. A receptacle to hold milk, and provided with rubber teats, known as an "artificial mother," may have to be provided in some cases. Warm cow's milk diluted with equal parts of boiled water, and to which some sugar has been added, together with a few eggs, may be given instead of the mother's milk, where the latter is not available. A sow is said to give from 7 to 14 pints of milk daily, the composition of which is as follows·

	Per Cent		*Per Cent.*
Water	82·37	Albumin	6·09
Solids	16·73	Sugar	4·04
Fat	6·44	Salts	1·06

The fat content may vary from 4 to 7 per cent.

If it is required to rear little pigs in complete isolation, they can be placed in bins covered with cellophane. Each bin should be attached to a forced ventilation system, and the food troughs filled from the outside, through rubber tubes.

A false floor of wire mesh makes cleaning out the bins during the animals' stay unnecessary.

Overlaying by the Sow.—The sow may be a clumsy mother, and should be got rid of if this is suspected. In the case of a gilt farrowing for the first time, overlaying may be due to inexperience, and she should be given another chance. An

old sow may become clumsy owing to defective vision, hearing, or sense of smell. A large unwieldy-sized sow is more likely to overlay the young pigs than is a well-formed, medium-sized animal. Long straw, tree twigs and shrubs may entangle the young pig after birth, usually by the navel cord, and they are thus unable to escape when the mother lies down. The pen or hut should be provided with a farrowing rail, preferably one supported outwards from the wall, and not upwards from the floor, or a farrowing crate provided The rails should extend all round the inside of the building, whilst the floor space should be sufficiently large to allow the sow to lie at full length and still have a passage left all round her.

A better method of preventing overlaying and damage to the little pigs is to rail off one side of the pen, or even to fix a strong hurdle or some bars across one corner. The lower rail or bar should be at least about 9 inches from the ground to allow the piglets freedom to pass. Some dry straw bedding should be provided in this secluded corner, and either a plentiful supply of straw overhead, about 9 inches from the floor, or in place of a straw " roof " an electric light bulb or low wattage infra-red lamp may be fixed about 2½ feet over the bed. The little pigs, after feeding, will naturally migrate to this warm corner and huddle together. They will thus obtain their full quota of sleep which is so essential to young animals at this age, and this will in turn enable their mother's milk to be fully digested. Not only will the piglets themselves be healthier and stronger, but the barrier between them and the sow prevents the latter from doing any damage to the litter. Thus the little pigs have free access to the mother's side for feeding, and can then return to sleep in peace in a warm comfortable bed, safe from danger. Not only does this system repay any small expense involved by providing healthy young stock, but it saves that so frequent loss per litter due to pigs being overlaid by the sow.

Some sows, notably those bringing up their first litter, may savagely and deliberately damage the little pigs, and cannibalism is not unknown. The sow may devour all her young, but it does not necessarily follow that she will prove to be so savage at her second litter. It may well be that she is suffering from a chronic deficiency in certain minerals or vitamins, and

particularly in calcium and magnesium. If such an animal is properly managed, and allowed access to a plentiful supply of green food, with a chance to forage around, she may yet turn out to be a good mother when her turn comes to produce the next litter.

The other causes of sows eating their young are said to be fright, failure to remove the afterbirth or a dead piglet, nervousness and thirst, but there is little doubt that improper nourishment during pregnancy acts as a predisposing cause, whilst there may well be genuine cases of cannibalism due to a hysteria or mania resulting from ovarian disturbance.

A sow should never be in too fat a condition at the time of farrowing, as she is likely to have some fatty infiltration of some of her internal organs, and to find the act of farrowing a difficult one. She may give a very small litter, or even farrow dead piglets. If the number of pigs per litter in a herd begins to drop suddenly it is well to examine the condition of the sows. As a general rule the rather poor-looking sow will often prove most prolific, whilst the number of pigs per litter will decrease as the sows increase in fatness. The "show" type of sow is not likely to give a big litter, and it is essential that the pregnant animal be allowed plenty of exercise, and fattening foods cut down. This is not to suppose that a "razorback" condition is suggested, but that the medium-conditioned animal with a good reserve of protein, vitamin, and minerals, generally is best for fecundity.

The little pigs can easily be chilled and starved, unless the pigman exercises vigilance for the first few days of their lives. Premature exposure to severe weather, and draughts in badly ventilated houses, may reduce the external temperature of the little pig to such an extent as to cause death. It must be remembered that at the time of birth the little pig is externally warm, and endeavours should be made to ensure that all the little ones be kept warm. Even the adult pig has no thick hairy coat comparable with that of the other farm animals, and the period immediately following birth is one in which the little pig is particularly likely to contract a chill The mother herself may fall a victim to exposure or to draughty and wet farrowing pens, huts or other buildings She may have farrowed out of doors in bad weather and have contracted an

infection or chill which may send her temperature up, and decrease or even stop altogether her flow of milk, so that the little pigs may suffer from starvation and die unless the matter is attended to. Apart from the causes mentioned, this form of agalactia may often be traced back to the sow's pregnancy days when she may have been kept on pasture seriously deficient in some vital food element. Any arrest in the mother's milk flow is serious for the newly born pig, and an "artificial mother" has to be provided. Some sows are sensitive to the sharp teeth of the little pigs during suckling, and may refuse to allow the little pigs to suckle. The sharp teeth of the young animals may be slightly pruned with a strong scissors if necessary.

Weaning, Castration and Spaying.—The little pigs will require careful watching when they are about three weeks old, as this is the period when, if there have been any defects in the feeding of the sow, the iron content of the mother's milk may be at a low ebb, and "anæmia," with its attendant "scour," may appear in the litter.

Having been accustomed, by means of the creep feed, to eat some supplementary food from about the age of four weeks, weaning becomes a gradual process. The young pigs should be removed from their mother when they are eight weeks old. Some people advocate weaning at seven weeks, or even six, in an attempt to reduce the "maturity" period and bring the pigs to slaughter for pork or bacon a few weeks earlier than is usual. Such attempts as have been made to force the pace in this way have not been successful, and experience has shown that eight weeks is the safest period for weaning if trouble is to be avoided later. The digestive system of the little pig cannot change to suit the convenience of the herd owner, and bringing the little animal on to a "solid" ration too early in life will result in fatalities. About a fortnight before weaning the sow's food should be changed so as to approximate as close as possible to the composition of the youngsters' ration when weaned. The weaners should be mixed in batches and moved to fresh quarters. After being kept in batches of twenty or forty for a few weeks, they can be drafted into the fattening house in lots of ten. At weaning, some skimmed milk or whey from a non-tuberculous or pasteurized source is most useful. Compounds for the preven-

tion of anæmia can be injected before this stage, and one injection may suffice for the pig's life.

For the fattening pig the exercise must be cut down, and it is often the custom to group the weaners together in improvised buildings prior to bringing them in to the main fattening pens. These little animals must have warm, dry pens and particularly sleeping quarters, if they are to make the most use of their ration. Keeping pigs on straw and manure beds leads to infections of various kinds, and particularly to skin diseases. Pigs pass many bacteria in the fæces and diseases may easily be communicated in this way from one lot of pigs to another. The swine erysipelas organism is often present in the bowel of normal healthy pigs, and the disease can be transmitted in that way. The ration must not be too concentrated at first otherwise the young stock will develop digestive troubles leading to impaction of the stomach, gut œdema, etc., so that care is required for the first few weeks in particular. The stock should have been wormed before passing into the final fattening stage, and there are various worm remedies on the market. The thing to note is that to kill and expel the worms requires the use of a drug which may kill the pig as well if the directions for use are not followed scrupulously. Care should therefore be taken to see that the correct dosage is followed. Treatment against the bowel worm and the lungworm can now be combined in one dose.

They should be weighed weekly if possible and the weights noted so as to check up on the gain or loss. In moving pigs over concrete floors care must be taken not to rush the animals, as this may easily cause a pig to slip, particularly with the hind-legs which tend to spread apart causing a rupture of part of the muscular insertion into the pelvic bone. This is very painful to the pig, and the animal will be unable to walk afterwards. It is the sort of accident that often happens to fat sows or sows heavy in pig. After such an accident the animal lies on its belly with the hind-legs spread out like some big sea-lion. Attempts to raise the animal on to its hind-legs fail, and the legs will be wasted and covered with bed-sores long before any spontaneous recovery is possible, so that slaughter is the only thing to consider in such cases.

The skin of the pig can be kept soft and supple by occasion-

ally rubbing with oily dressings, most of which have a base of liquid paraffin, but this should not be needed in a well-kept herd.

In moving the animals off to the abattoir, equal care needs to be taken in loading and unloading, and breeders should not encourage the use of electric goads which frighten the life out of the animals, and cause them to tumble down the runway from transport motors, with the result that the animals suffer damage, such as bruising and fractured bones. Quiet, patient handling is essential.

Male pigs are usually castrated when they are between four to six weeks old, and the operation in the hands of an expert takes very little time provided help is available to secure the animals.

The pigs may be held by the hind-legs, kept well apart, but not too widely, as this tends to make it difficult for the operator to grasp the testicle in the scrotum, the little pig's head being held between the attendant's legs. Others prefer that the attendant should sit, with the pig's head held under the left elbow, the pig's body over the attendant's knees, belly upwards, hind-legs held apart. The site of operation can be disinfected by a swab soaked in antiseptic solution; tincture of iodine should not be used. A swab of cotton wool fixed to the end of a skewer and kept in a solution of antiseptic is very useful for this purpose. It is perhaps unnecessary to add that the operator's hands and instruments should be clean, but as this operation is so often performed by people who are not veterinary surgeons and whose knowledge of antisepsis is of the scantiest, cleanliness must be stressed, especially as these people do not have to follow their cases into the abattoir later on and see the results of their clumsy "pruning" in the form of abscess formations at the site of the operation.

The most valuable part of the pig's carcase is the ham, and this should be remembered when performing castration. The operation wound should not take the form of a large gash across the thighs, so as to leave an ugly scar, with possibly an abscess in the ham when the pig grows to bacon and pork size, nor, to ensure drainage, should it be too high up the scrotum. The wound should be just large enough to enable the operator to squeeze the testicle out gently, and the peritoneal covering should be severed with the skin wound if

possible. It is for the operator himself by virtue of his experience to judge as to how much pressure to exert upon his knife when making the skin incision, and so to avoid a cut directly into the substance of the testicle. Where such a deep incision is made, pressure of the operator's fingers in grasping the testicle may cause testicular tissue to be distributed all over the wound and hind-quarters of the little pig.

The peritoneal covering when incised will slip back to the epididymis. The testicle can then be grasped, the knife inserted between cord and vessels, the cord severed, and the vessels scraped with gentle traction and the testicle removed. In certain cases of hernia it may be advisable to remove both testes through the one wound, and afterwards suture the skin wound, leaving a small opening for drainage. The wound should then be swabbed with antiseptic solution and the little pig released and allowed to run out at grass, provided the weather is suitable.

Female pigs are operated upon for removal of the ovaries, or spaying. This operation in the hands of an expert is as simple as that of castration. The precautions to be taken are similar, and the wound is made in the left flank, the operator inserting his fingers and withdrawing the ovaries, afterwhich the skin wound is sutured. The attendant usually lays the animal on the ground on its right side, but the Chinese have a method whereby the attendant can be dispensed with, the little gilt being tied by the hind-legs, head downwards, to a board, whilst the fore-limbs are similarly secured to the other end of the board or post. Thus secured the pig can be operated upon quite easily by one man, and it is claimed for this method that the head-downwards position of the animal brings the intestines down and away from the ovaries, thus facilitating their easy removal.

This operation of spaying young gilts was once very common, but is fast dying out, as practical experience has shown it to be an entirely unnecessary operation as far as the animal's fattening qualities, etc., are concerned. Some of the reasons adduced for performing this operation are that the gilt in œstrus causes a lot of trouble, goes off her food for a time, and thus does not fatten up so rapidly as the

spayed gilt or castrated hog. It is often stated that if a gilt or sow in œstrus is slaughtered during the period, the meat from such a carcase will not " take the cure " for manufacture into bacon, is inclined to be more watery and flabby, and a likely cause of " taint " in the bacon.

The writer has had some years of experience of gilts being slaughtered in œstrus, and has carefully investigated these statements about such flesh not being suitable for curing into bacon, etc.; the truth of the matter is that thousands of gilts are slaughtered annually whilst the animals are in œstrus and their flesh cured into bacon. As far as is known, no one has ever been able to tell the difference between bacon cured from such gilts and that cured from the flesh of normal castrated hogs or spayed gilts. There is no noticeable difference whatsoever in the flesh before curing, during curing, or after curing into bacon.

Bacon curers who also breed pigs do not as a rule have their gilts spayed. Not only is the operation considered to be a waste of time and effort, with a possible risk of loss of life (as is the case after any operation), but the interference with the fattening which œstrus is said to cause is so negligible that they prefer their gilts intact to the risk of having an ugly scar, with possibly an abscess, left in the flank. The flank produces some valuable cuts of bacon, and it frequently happens that a spaying operation may have been performed with great success and every aseptic precaution, yet a thin plate of bone tends to grow in the fat at the site of the operation. This bony plate may pass unnoticed until the cured side of bacon is in process of being sliced up in a retail shop, in an expensive bacon-slicing machine possibly. It is obvious, therefore, that bacon curers tend to look with disfavour upon any operation likely to mar in any way the sides of bacon or the hams which they hope eventually to obtain from their pigs.

It has been thought that this thin bone plate found sometimes embedded in the fat of the flank at the site of the spaying operation wound may have come from some damage inflicted unwittingly by the operator to the transverse process of one of the lumbar vertebræ, or to the ilium; but whilst the bone is occasionally found to be attached to either the ilium or transverse process of one of the lumbar vertebræ, it is also

found entirely free of attachment to any of the skeletal bones, being surrounded by a complete layer of fat.

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Chapter 4

PIG FEEDING

FEEDING is closely linked with the general management of pigs, their care and housing; and as pigs are bred for the production of pork and bacon, it follows that, to obtain the best return for the money expended, great care must be exercised in feeding so as to produce a maximum of profit for the minimum of outlay. For large breeders and feeders the Scandinavian type of fattening house is of great help, and the modern demand for lean bacon and small joints has made it possible for the pig farmer to obtain a return for his expenditure twice a year instead of only once.

The importance of the science of nutrition is acknowledged nowadays, and great strides have been made in our knowledge of pig feeding, thanks to numerous research workers, agricultural colleges, and practical farmers. There is still much to be done and a good deal of ignorant prejudice to be overcome, and we still find many people who take up pig farming with little or no knowledge of the animals they are handling, and who are prone to adopt any well-advertised " balanced ration " for pigs, without either bothering or having the necessary knowledge to enquire into its composition and suitability for the class of animals they are feeding. In such cases the importance of paying some particular attention to the ration is not realized until losses in pigs due to dietetic errors and deficiencies compel them to regard the ration as something worthy of careful study.

It is obvious that a ration must not only be properly balanced—*i.e.* that it should contain enough of its proximate principles, protein, carbohydrates, fats, etc.—but that they must also be in their proper proportion, together with minerals and vitamins, to enable the pig's digestive system to assimilate them to the best advantage. The ration must be fed at regular specified intervals if good results are to be expected.

Foods are conveniently divided into water and solids.

The solids consist of organic and inorganic matter (minerals or ash). The organic matter can be divided into nitrogenous and non-nitrogenous substances, the former as proteins and non-proteins, and the latter as fats and carbohydrates. The carbohydrates may again be subdivided into soluble carbohydrates and crude fibre.

In addition, we also have the "accessory food factors" or vitamins as well as minerals.

Water.—All foods contain some water, but roots such as turnips, swedes and mangolds are especially rich in water. Pasture grass contains a large amount of moisture, as also do wet brewers' grains. Foods are sometimes classified or spoken of as "succulent" foods when they contain over 70 per cent. of water, and foods with a low water content are called "non-succulent." The cereals contain on an average only about 11 per cent. of water, whilst green grass loses much of its water content when dried and made into hay. Water is, of course, an essential part of the animal body and is vital to life.

Proteins.—These are the nitrogenous substances or, as they are sometimes called, the "albuminoids." There are really two groups: the true proteins and the non-protein nitrogenous substances or amides. Proteins always contain nitrogen, and in that they differ from the fats and carbohydrates. In addition to carbon, hydrogen and oxygen, proteins also contain sulphur and sometimes phosphorus. The simplest proteins are the albumens and globulins found throughout the animal and vegetable worlds.

The non-protein nitrogenous substances are much less complex than true proteins, and are also present in animal and vegetable matter. The flavour of meat is due to meat extractives which are non-protein nitrogenous substances, whilst ammonia salts and nitrates must also be included in this group, as also are glucosides, alkaloids, lipoids, amino-acids and amides.

Some of these substances are highly poisonous, and in the case of pigs one might mention the glucoside found in Java beans. These have been known to have been fed to pigs with disastrous results, as under certain conditions the glucoside is split up into hydrocyanic acid, acetone and glucose.

Alkaloids are also in many instances poisonous substances, but the bulk of these non-protein nitrogenous substances are made up of amides and amino-acids, and these latter form the groundwork of protein, an amino-acid being a fatty acid in which an amino group replaces one or more of the hydrogens in the acid radicle. Proteins are assimilated by the animal in the form of amino-acids—*i.e.* the protein must be broken down to amino-acids before it can be assimilated and the nitrogen passed on for the repair of broken-down body tissue.

It is the protein that builds up muscle and keeps it in repair; it is also required for the internal secretions, and is absolutely necessary for the maintenance of the body.

A deficiency of protein in a ration causes the animal to draw upon its supply of body protein for its normal functions, whilst the ration thus becomes unbalanced and the digestibility of the other ingredients of the food is reduced. An excess of protein in the ration is not only expensive in the long run, but also upsets the digestibility of the food, whilst much of the excess fed is wasted by being passed through the animal body without a proper metabolism, and leads to digestive derangements, kidney trouble and general unthriftiness, which may be especially marked in breeding sows.

Carbohydrates.—The soluble carbohydrates are all composed of carbon, hydrogen and oxygen, with the hydrogen and oxygen present in the same proportion as in water (H_2O). These foods are chiefly of vegetable origin, and animal flesh contains very little carbohydrates. Soluble carbohydrate is also spoken of as "nitrogen-free extract," and foods possessing a high percentage of nitrogen-free extract are called "carbonaceous foods." The cereal foods contain from 60 to 70 per cent.—*i.e.* oats, maize, rice, etc.—whilst potatoes contain 17 per cent. and molasses 55 per cent. of soluble carbohydrate. Roots such as turnips, swedes, etc., contain a hexose, grape sugar or dextrose. Milk sugar or lactose is present in milk, but the most important carbohydrate is starch, present in large amounts in cereals and leguminous seeds.

The soluble carbohydrates are digested and utilized by the animal body to supply heat and energy, whilst any excess is converted and stored in the body as fat. In the pig the fat

is stored in two layers beneath the skin, and also in the region of the kidneys, and to a lesser degree in the liver and muscles. Carbohydrates are easily digested, and form the bulk of the pig's ration.

Crude Fibre.—Foods containing from 15 to 20 per cent. of crude fibre are generally classed as coarse foods, whilst those containing a lesser percentage are known as concentrated foods, although this division according to fibre content is not by any means satisfactory, as certain "coarse foods" have less than 15 per cent. of fibre. A concentrated food contains much nutriment, whereas a coarse food contains relatively little. Oats, for instance, a concentrated food, contain 10 per cent. of fibre, hay contains 25 per cent. and wheat straw 41 per cent. of fibre. A root food like the swede contains only 1 per cent. fibre, but is not a "concentrated food."

Some fibre is necessary in the food of animals, except in the very young, as it forms the roughage which assists peristaltic movements of the intestines and the stomach movements, and stimulates the secretion of the digestive glands. A ration consisting of no crude fibre would soon lead to trouble; thus fibre, although the digestible portion thereof is small and the energy it provides cancelled out by the energy necessary to its digestion, is an essential part of the diet.

The Fats.—The term fat is used to cover certain other substances such as waxes, gums, etc., included in the crude fats or oils. The fats are compounds of glycerin with fatty acids such as stearic acid, palmitic acid and oleic acid. Fat is rich in carbon and hydrogen and relatively poor in oxygen. The fatty acids making up the fat have different melting points, and the consistence of fat depends largely upon the proportions of these fatty acids. Palmitic acid and stearic acid, which are found chiefly in animal fats and some of vegetable origin, both have a high melting point, whereas oleic acid, which is present in such oils as linseed, rape, etc., has a low melting point. If, therefore, fats containing a high percentage of oleic acid are fed to pigs, and fed in excess, there is a tendency for the formation of soft and oily fat in the pig's carcase.

Linseed contains about 40 per cent. fat, and cottonseed contains about 23 per cent. The oil is often extracted be-

fore these are used for animal foods, and the "cake" residue contains about 11 per cent. of fat. When cod-liver oil is added to the pig's ration, care should be exercised not to use an inferior quality oil and not to feed in excess of requirements, as this produces not only a soft oily fat, but when a cheap oil is used and fed in excessive doses the fat in the slaughtered animal tends to be discoloured; a dark colour is formed, and instead of the firm white fat normally found in pigs, one gets a brownish tint throughout the carcase fat, which, apart from the soft oily nature of such fat, renders the whole carcase liable to seizure by the meat inspector.

Fat when digested forms energy like the soluble carbohydrates, but its energy value is two and a half times that of carbohydrate food. A deficiency of fat lowers the digestibility of the ration, whilst an excess causes digestive troubles. Excess fat is stored up in the animal body, and care should be exercised in feeding fatty foods to an animal like the pig which is deprived of exercise, as this may lead to mineral deficiency owing to the combination of the fatty acids with the bases, and their excretion from the body.

The oily foods requiring care in their use are chiefly maize germ meal, rice bran, fish meal of high oil content, linseed cake, nut cakes, and cod-liver oil. The dose of halibut-liver oil is so very small that it might be a good substitute for cod-liver oil for pigs were its price not so high.

Minerals.—These constitute only about 3 per cent. of the whole body, but are of great importance in feeding. The minerals found in the body are calcium, sodium, potassium, magnesium, iron, and the non-metallic substances, phosphorus, sulphur, chlorine and iodine, together with traces of other minerals. These substances are essential to the animal body and their absence soon leads to death, whilst their presence helps in the assimilation of the other constituents of food. An example is the pepsin in the pig's stomach, which can act as a digestive juice only in the presence of hydrochloric acid, hence the necessity for providing the chlorine in the mineral elements. The absorption of the food and the carrying of the food to the tissues by the blood depends upon the minerals, too, the hæmoglobin of the blood being an iron compound. The breakdown of tissue in the body must

be provided for, as well as the secretion of milk in the sow.

Pigs are fed mainly on a ration consisting of cereals and their byproducts, and these generally contain a low percentage of calcium oxide and phosphoric acid, hence the necessity for adding such minerals to the ration. Provided pastures are properly treated with fertilizers, lime, etc., animals obtain some of their minerals from this source, and fish meal or meat and bone meal contain a high content of lime. The requirements of a fattening pig will naturally be less than those of a breeding sow. Milk added to the ration and an access to some good pasture-land will often provide the necessary mineral requirements. Pigs will soon give an indication if suffering from acute mineral deficiency by attempting to eat mortar, lick the walls of the pens, eat their litter and dung, etc. Mineral deficiency retards growth seriously, causes the production of small litters, and leads to the farrowing of dead pigs.

Experience shows that the addition of certain mineral elements and vitamins to any good ration helps in the better digestion of the food by the pigs. It must be emphasized that these substances should be added merely as trace elements in the ration. The tendency is always to *add too much*, and to add the minerals in a *most unpalatable form*. Long before antibiotic feeding became the fashion, mineral and vitamin "tonics" added to the pig food in small amounts were found useful in getting pigs up to slaughter weights in record time. The same applies to the feeding of such substances as dried (boiled) liver in the form of small additions per pig per ration. The lack of good results from mineral feeding is often due to the unpalatable form in which the mixture is fed, and to the excessive amounts given per animal.

The Vitamins.—These accessory food factors have been found to be essential to growth, good health and breeding. Many of them have now been chemically determined. Minute quantities only are required by the body, and they are present in certain body tissues and organs as well as in some foods. Normal animals fed under natural conditions obtain their vitamin requirements from the wide range of foodstuffs at their disposal, but under artificial feeding conditions it becomes necessary to provide the required vitamins in the ration.

Deficiency of certain vitamins in the foods retards growth and produces changes in the skeletal structure, resulting in a variety of conditions designated "avitaminosis."

Vitamin A, as it is called, is found in green food, cod-liver oil, halibut-liver oil. It is believed that this vitamin is really two factors—*i.e.* vitamins A_1 and A_2. Unrefined pig fat also contains this vitamin, whilst it is present only in very small amounts in certain vegetable oils. It is essential to growth, and its absence gives rise to stunted growth, and conditions such as "osteomalacia" and a degeneration in the cells of the parathyroid glands, with an increase in the acidophil cells.

Vitamin B_1 (aneurine or thiamine) is found in some seeds, egg yolk, peas, lentils, wheat, rice-seed germ, some vegetables and fruit. Yeast is a rich source of this vitamin, and its absence in the food leads to "beri-beri," "polyneuritis" and growth failure. Vitamin B_2 or riboflavine is present in similar foods, and lack of this substance in the diet causes "pellagra," another wasting disease. B_3, B_4, and B_5 are growth factors, and B_6 (adermin or pyridoxine) is the rat anti-dermatitis vitamin, absence of which from the ration of piglets may produce epileptic fits in animals fed on such a diet. Vitamin B_{12} is the anti-anæmia factor which is very valuable in combating piglet anæmia, the so-called "bowel œdema," and various other conditions in the pig where a rapid toning up of the system is required.

Vitamin C (ascorbic acid) is the anti-scurvy factor which is present in fruit juices and vegetables. It is present in lemon and orange juice, tomato juice, and raw swede juice. Its absence from the diet gives rise to "scurvy" and some degeneration in the parathyroid glands with hæmorrhagic patches.

Vitamin D_2 (calciferol) is found in milk, egg yolk, meat juice, cod-liver and halibut-liver oil. It is concerned with the use by the body of calcium and phosphorus, and in conjunction with natural sunlight it prevents rickets. A deficiency of this vitamin results in some hyperactivity of the principal cells of the parathyroids. Vitamin D_3 is essential for bone development.

Vitamin E (tocopherol) is found particularly in wheat germ and in red meat. It is the sterility-preventing vitamin, and exerts an effect upon fecundity. Experiments carried out on

rats have shown that the absence of this vitamin causes sterility by inducing the death and absorption of the embryos.

Vitamin G is found in linseed, peanuts, cottonseed, soya-bean meal, yeast and liver.

Vitamin K_1 and K_2 is found in green leaves and vegetables, and is the anti-hæmorrhagic factor essential for the production of prothrombin.

Vitamin P (citrin or eriodictyol) is found in lemon juice, with vitamin C, and it helps to prevent fragility in the walls of the capillaries.

Other substances are nicotinic acid or niacin, the pellagra preventing factor; *p*-aminobenzoic acid, a compound of folic acid; choline; folic acid, which is concerned in blood cell formation; inositol, the alopecia preventing factor in mice; and pantothenic acid, which prevents dermatitis in birds. Many of these vitamins are yielding up their secrets to the chemists and it is possible to purchase them in liquid and tablet forms. The vitamin potency of cod-liver oil and halibut-liver oil, as well as many other vitamin preparations, is standardized according to recognized international units, and this should always be looked for when purchasing these substances. As most vitamins are found in the food, it should not be necessary to add them artificially to the ration, but in exceptional cases where it is necessary to make such an addition, small quantities are sufficient.

Antibiotics, etc.—The use of antibiotics and antibiotic products is now general in pig feeding, and substances such as penicillin, chlortetracycline, aureomycin, oxytetracycline, bacitracin, vitamin B_{12}, and anti-thyroid products have all been tried out as additions to pig food. Even before these substances were discovered, it was well known that small additions of trace elements to a good ration would improve the palatability and digestibility of the food. The addition of traces of antibiotics to the pig food enables the animal to make better use of the food, to put on more weight in a slightly shorter period than would be the case with an "undoctored" ration. Chlortetracycline has been found to be slightly more stable than the other antibiotics, but animal food manufacturers are improving the keeping qualities of these substances constantly. The amount necessary to be mixed with a ration is very small,

and in the case of penicillin it can be as low as 2·5 grammes per ton of food, nor need it be more than 7 grammes per ton. Chlortetracycline with vitamin B_{12} is effective at no more than 16 grammes per ton of food.

The antibiotics can be added to the creep feed of little pigs from three weeks old, and they are particularly useful where unthrifty piglets are concerned. The antibiotics appear to destroy some harmful bacteria in the intestinal tract, and thus help to prevent those scours which are often a bane in some piggeries. The best growth rates appear when the pigs are ten weeks old, and the beneficial effect upon growth rate and food conversion continues until the animals are from 18 to 20 weeks old. After that age there does not seem to be any great advantage in antibiotic feeding.

From that age on to slaughter age, pigs fed on a good unsupplemented ration show just as much growth and food conversion rates. Unthrifty weaners, and those pigs with enteritis or scour, can be placed together in a pen and fed on an antibiotic supplemented ration with advantage. Hypodermic injection of an antibiotic intramuscularly into emaciated, underweight, enteritic piglets, plus the feeding on an antibiotic ration, will change such animals into normal healthy pigs in an amazingly short time. Dysentery pigs respond to streptomycin also, but it should be given by means of a pig doser in some water, and not fed with the ration, otherwise the effect is nullified. Sulpha drugs also work wonders in the case of these unthrifty pigs, as many complications occur, and what may appear a plain case of "scour" prove to be one of virus pneumonia with scour as a secondary complication.

Anti-thyroid products have also been used to increase growth rate in pigs by producing a condition of hypothyroidism which leads to an increase in fatness at the expense of conformation. If such substances are to be used at all it should be under strict veterinary supervision, and they should not be used as food supplements. If the good effect of antibiotic feeding depends even to a small extent upon the inhibition of certain bacteria of the intestinal tract, then it is fairly certain that in due course a bacterial resistance will be developed to these antibiotics and the good effect destroyed. It is useful to remember that mineral and vitamin trace elements used as

food supplements in small doses will also enable pigs to improve the growth rate due to better food conversion, provided they are given in a manner which enables the pig to digest them properly. The mineral chiefly concerned is copper which is added to the feed at the rate of 100-150 parts per million. It is of interest to note that it is only with pigs that this practice may safely be carried ont.

Rations for Growing Pigs.—Barley meal is regarded as the standard food for pigs, and is found in most pig rations. The late Professor Wood of Cambridge gave a very useful table sbowing the weight of a number of feeding-stuffs equivalent for pig feeding to 1 lb. of barley meal. The table below is reproduced by kind permission of tbe Ministry.

Where manufactured foods are used, separated milk forms a useful addition, and a phospbate-containing food like steamed bone flour is useful if the ration is deficient in ash.

It is estimated tbat when properly looked after young pigs will use less than 3 lb. and often less than 2½ lb. of food per pound of gain. The nutritive ratio of the commencing ration should be about 4 to 1, and this should he gradually widened as the pigs increase in weight, until at 200 lb. live weight it

– Maize meal	14 oz.
+ Cocoanut cake	14½ "
+ Palm-kernel cake	15 "
+ Maize gluten feed	1 lb.
Rye	1 lb.
Wheat	1 lb.
+ Gram	1 lb.
+ Peas	1 lb.
– Acorns, dried	1 lb.
+ Ground-nut cake, decorticated	1 lb.
+ Linseed cake	1 lb.
Fine middlings	17½ oz.
+ Beans	17½ oz.
Coarse middlings or sharps	17½ oz.
+ Oats	19 oz.
– Potatoes	4 lb.
– Mangolds	8-10 "
– Swedes	8-10 "
– Carrots	8 "
– Separated milk	8½ "

The sign – denotes deficiency in protein and ash and + denotes richness in protein and ash.

has a value of 6 or 7 to 1. The ration should not be too laxative, and some bran can be used to ensure a certain amount of laxativeness if necessary, but care should be used so that too much indigestible fibre is not given to young pigs. The food may be mixed with water, unless milk or whey is used, and the following amounts of water are reasonable quantities to add: For young pigs, 2 lb. water to 1 lb. food—*i.e.* 5 lb. food to 1 gall. water.

This proportion is gradually reduced until the finished pigs receive only 1¼ lb. of water per pound of food. This propor-

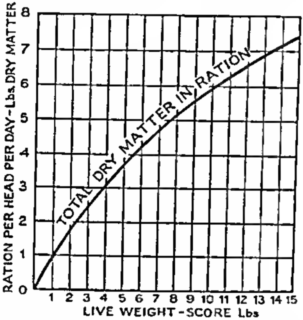

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FIG. 36.—GRAPH SHOWING FODDER REQUIREMENTS BY PIGS OF VARYING WEIGHT.

tion has been found to give the food sufficient thickness for practical purposes, and is not so thin as to lower the growth rate. In hot weather the food may be made thicker if a separate trough is provided for water, so as to guard against thirst. In winter the food should be mixed with hot water. Pigs are frequently given far too much water, and this they have to drink before reaching the solid food at the bottom of the trough. It is possible that the superiority of dry feeding over wet feeding is due to the fact that the wet feed is usually much too watery.

Another factor that can influence the growth rate in pigs is over- or under-feeding. For larger pigs from fifteen to twenty minutes at the trough three times a day is sufficient. Pigs should be given either just as much food as they can consume during that time, or the trough should be shut off after twenty minutes. Slight under-feeding is better than over-feeding, as the latter interferes with the growth rate by causing indigestion. With slight under-feeding pigs are said to grow so well that what is enough food on one day is too little for the next. Young pigs up to 60 or 70 lb. live weight will do well on five or six meals a day, each of ten minutes' duration, and at two-hour intervals.

It is recommended that the food of the nursing sow should be changed during the last fortnight before weaning, so that it shall approximate in composition to that which the weaners will receive when they are fed separately. These alterations of food should be gradual, and they accustom the little pigs to get over the change of diet before weaning. About ½ pint of skimmed milk or whey is invaluable to a young pig, but care should be taken to ensure that the milk or whey comes from a non-tuberculous source.

As milk from tuberculous cows forms one of the main sources of that disease in pigs, all milk and milk products should be pasteurized before feeding, otherwise there is a danger of introducing tuberculosis into a clean herd. This is on the assumption that the milk is not from tubercle-free cows. When fed to pigs about 3½ lb. of milk are said to equal 1 lb. of mixed cereal meal. To make up 1 lb. of cereal meal equivalent requires 6 lb. of separated milk or 12 lb. of whey. One pound of dried whey is equal to a gallon of separated milk, or to 1½ gallons of liquid whey. For very young pigs whey should be diluted, but it is an easily digestible food for all pigs.

If the baby piglets have to be removed from their mother soon after birth, they should be placed in warm surroundings, with a temperature of from 80° F. to 75° F., being gradually decreased to room temperature when the pigs are about seven weeks old. The food provided should be in liquid form, and as near as possible to that of the sow's milk, both in composition and temperature. A diet of 93.5 per cent. dried skimmed milk and 6.5 per cent. lard together with the needful vitamin and mineral

supplements has been fed, with the introduction of dry food after the first seven days. During the first week the little pigs should be fed at least six times daily, and the number of feeds should be gradually reduced to weaning age, when three times daily will be sufficient. The gradual introduction of dry food means that the liquid diet can be eventually replaced entirely (*e.g.* 30 per cent. dried skimmed milk, 26 per cent. dried grass meal, 20 per cent. fishmeal, 16 per cent. molasses, 6·4 per cent. bone meal, 1·6 per cent. salt with vitamin and mineral supplement containing antibiotics). The injection of iron and B_{12} during the first week should help the pigs. The following diet has also been used: sucrose 40 per cent., maize starch 25 per cent., casein 15 per cent., whole-milk powder 10 per cent. dried yeast powder 5 per cent., with the usual mineral, vitamin and antibiotic additions. As has been pointed out earlier in this book, a run on good luscious pasture once daily, if only for an hour or so, ensures healthy growth.

Another ration used is made up of sucrose 40 per cent., maize starch 20 per cent., dried yeast powder 3 per cent., dried wholemilk powder 10 per cent., casein 22 per cent., minerals 5 per cent. (ferrous chloride 6·4 per cent., sodium chloride 4·5 per cent., magnesium sulphate 11 per cent., sodium dihydrogen phosphate 24·7 per cent., calcium phosphate 14 per cent., calcium lactate 30·4 per cent; all with an addition of a mixture of vitamin A 1600 international units per 100 grammes of diet, and vitamin D 400 I.U. per 100 g., vitamin B_{12} and some antibiotic). A trace of zinc carbonate in the feed helps to prevent certain skin rashes and some unthriftiness. Some "trace elements" are most useful, particularly where unnatural methods of rearing are being adopted.

Where possible it is useful to keep weaned pigs in batches of twenty, thirty or forty for a week or two, later drafting them out in lots of ten for fattening, all mixing of pigs from various litters being done soon after weaning, and the pigs moved to fresh quarters at the same time.

Soft, oily fat has been mentioned, and this condition must be avoided. Experience indicates that the proportion of oil in the ration of feeding pigs should never exceed 3 per cent., and it is better to keep the amount below this figure.

There are certain foods which people who are breeders,

feeders, and large-scale curers of pigs do not like to feed to pigs. These are: rice meal, fish meal, maize-germ meal, hominy chop, meat meal or meat and bone meal when rich in fat, brewers' grains, linseed cake meal, excess of maize or gram, palm-kernel cake, swill and hotel waste. The foods which are considered safe to use are: barley, oats, wheat, rye, whey, potatoes, tapioca, and maize or flaked maize up to 15 per cent. of the ration only, albuminous foods such as sharps (up to 40 per cent. of the ration), bran, separated milk, dried blood, dried yeast, peas, beans, whale meat (not exceeding 3 per cent. fat), meat meal or meat and bone meal (not exceeding 3 per cent. fat), extracted soya-bean or ground-nut meals, dried skim milk, whey paste, etc.

A committee studying animal nutrition in the United States of America point out in their report that nutrition is directly and specifically related to reproduction in farm animals. Ample energy is necessary for normal breeding, and swine require supplementary protein. Protein of animal origin or from good-quality green legume hays, such as alfalfa fed in liberal amounts, will adequately fortify the swine ration. The committee point out that dietary phosphorus, calcium, iron, iodine and manganese are all essential for successful reproduction of farm animals. Vitamin A in more than mineral amounts is also an indispensable dietary factor for the same function. Vitamin C or ascorbic acid has been shown to have a direct stimulating effect upon sterile males and "shy-breeding" females. This accessory food factor is also an indispensable factor for reproduction, but, unlike vitamin A, farm animals synthesize their own ascorbic acid, and require the added vitamin only when their own synthetic powers fail to provide ample amounts. The committee were not convinced that the addition of extra vitamin E to a normal ration had any specific effect upon reproduction in practical herd and flock management. They point out that some as yet unidentified dietary factors are required for successful parturition and suckling of young pigs by sows fed certain practical rations. Alfalfa hay, tankage or fish meal were found to be effective supplements to such rations.

The pigs should be earmarked and weighed regularly, and if the pigs do not come up to standard weights the matter

should be looked into. The following table shows the standard growth rate for pigs (East Anglian pig recording scheme):

Age in Days.	*Live Weight on Farm (Lb.).*	*Cold Dead Weight (Lb.).*
63	33	—
70	39	—
77	45	—
84	52	—
91	59	—
98	66	—
105	74	—
112	82	50
119	90	57
126	99	64
133	108	71
140	117	78
147	127	85
154	137	93
161	147	101
168	157	109
175	168	117
182	179	126
189	190	135
196	202	144
203	214	153
210	227	163
217	240	173
224	252	183
231	264	193
238	275	204
245	286	215

Feeding-stuffs may be grouped as follows:

No. 1. The Protein Rich Foods.—White fish meal, meat meal, wholemeat meal, blood meal, extracted earth-nut (ground-nut) meal, extracted soya-bean meal, linseed cake and meal, beans, peas, maize gluten feed.

No. 2. The Intermediate Group.—Cocoanut cake, malt culms, palm-nut kernel, cake and meal, dried brewers' grains, weatings, middlings or sharps, bran.

No. 3. Low Protein Group.—Wheat, maize, barley, oats, rye, dari, rice meal, locust-bean meal, maize-germ meal, tapioca flour, dried sugar-beet pulp.

Then there are the supplementary foods as follows, with weights roughly equivalent to 1 lb. of barley meal:

Potatoes, Sugar beet	4 lb.
Artichokes	5 ,,
Lucerne, Grass	5 ,,
Kale, Vetches	7 ,,
Mangolds, Swedes	9 ,,
Turnips	12 ,,
Separated milk	9 ,,
Whey	14 ,,

Finely crushed oats, in which the country is practically self-supporting, can be used to replace barley or maize to the extent of one-third of the total meal ration.

The barley meal used in ordinary rations may be replaced by selections from the low protein group (No. 3), the weatings by some of the intermediate group (No. 2), and the protein concentrate by some from No. 1, protein-rich group. If a vegetable concentrate is used as a main source of protein, 1½ lb. of chalk or ground limestone and ½ lb. salt should be added to each hundredweight of mixed meal. In the final stages of fattening, the ration may consist almost entirely of cereal meals and milling offals. The approximate quantities of meal required are:

Live Weight of Pig (*Lb.*).	*Per Head per Day* (*Lb.*).
60	2
110	3
150	4
200	5
250	6

Green food should be fed also. It has been found that it is unprofitable to exceed a meal allowance of 6 lb. or so. Store pigs can be allowed out of doors to pick up part of their keep from pasture and stubble, being brought indoors for the final fattening period of four to six weeks, whilst cabbage, rape, kale, roots and surplus market-garden stuff are all suitable foods.

The Ministry of Agriculture's suggested ration for in-pig and nursing sows is:

Cereal meals	55 per cent.	(Group No. 3).
Weatings	30 ,,	(,, No. 2).
Protein concentrate . ..	15 ,,	(,, No. 1).

It is suggested that the protein concentrate may consist of 5 per cent. white fish meal and the balance of any other

ingredients of Group No. 1. In-pig sows should get 2 to 3 lb. per head per day with green food *ad lib.* out of doors if possible. When vegetation is scarce, potatoes, mangolds and other roots may be scattered on the ground. Nursing sows should receive ¾ lb. per piglet per day, with plenty of green food. Piglets should be encouraged to eat as early as possible, and given all they will clear up twice a day, with green food. At first they may have equal parts of barley meal and weatings, or weatings and another cereal, with the chalk and salt mixture. At five or six weeks old a 10 per cent. protein concentrate should be added.

Experiments have shown that it is possible to feed pigs from 50 lb. live weight on 2½ lb. per head per day basal ration of :

Weatings	35 parts.
Barley meal	30 ,,
White fish meal	20 ,,
Extracted soya-bean meal	10 ,,
Lucerne	5 ,,

Supplemental bulky food can be fed according to appetite, and although the time taken to reach a live weight of 200 lb. may be increased by four to six weeks, the carcase quality is not appreciably lowered.

Full use should be made of outdoor feeding, and it is recommended to ring pigs before turning out to pasture, whilst shelters should be provided against the cold and wet.

Less satisfactory foods which have been used for pigs include hotel and house refuse, which must be used only after boiling (Foot and Mouth Regulations), and this food is always best used fresh. The feeding of uncooked potatoes is not recommended, although pregnant sows in the early stages and well-grown gilts on range are said to have been given as much as 16 lb. per head per day without detriment.

Potatoes should be thoroughly washed, and steamed or boiled for about forty-five minutes. All sprouts should be removed, and the water in which they were boiled must not be used for animal food. For replacing part of the carbohydrate food 4 lb. of potatoes are equivalent to 1 lb. of meal.

Swill does not form in itself a balanced ration, as it contains too much fat. Harmful substances such as soap and soda

may also be found in swill (see chapter on poisons, etc.). Swill should be collected daily, raked over, and boiled. Harmful substances should be removed. Under the Foot and Mouth Disease (Boiling of Animal Foodstuffs) Order, this boiling must be carried out for at least one hour. The excess fat can then be skimmed off. Boiling for three to five bours is better, as the swill forms a uniform pulp that mixes readily with meal, and does not tend to cause digestive troubles, provided harmful matter has been first raked off. Swill should be used fresh, otherwise putrefaction may occur and moulds may develop. Small quantities only should bc fed to a pig below 80 lb. live weight and to nursing sows.

Raw swill, which consists of about three parts moisture, is boiled or steamed under pressure and fed as a stiff "pudding." About 2¾ lb. of this swill is said to replace 1 lb. of meal. For young pigs swill is fed in small quantities, and gradually increased with middlings to provide vitamins and roughage, as swill alone is liable to cause constipation.

A ration for use with swill is:

Weatings	60 parts.
Flaked maize	15 ,,
Barley meal	15 ,,
Fish meal	5 ,,
Soya-bean meal	5 ,,

At 80 lb. live weight some 3 to 4 lb. of this meal can be given, the amount being gradually reduced to 2 lb. per head with swill added to appetite. At 100 lb. live weight the basic ration should be a mixture containing weatings and barley meal in equal parts, 2 lb. per head, plus as much swill as the pigs can eat. This is continued to bacon weight, but varied slightly each day according to the swill available, and if the pigs are loose the barley meal is then increased; if constipated, the weatings should be raised in proportion.

Pregnant and nursing sows can be housed in wooden huts and fed out on clover leys throughout the year with swill and occasional raw potatoes.

Properly handled, swill can be used successfully if the precautions already mentioned are strictly carried out.

Interesting experiments have also been made in feeding

sugar-beet tops, waste cabbage, kale and similar crops, with a limited meal supply.

Sugar-beet tops must be free from grit, clean, and should be introduced very gradually into the ration in the form of one or two tops per pig daily after the pigs have reached at least 80 lb. live weight.

Marrow-stem kale has been fed up to 20 lb., but it is advisable not to exceed 10 to 15 lb. daily for pigs of about 7 score weight. Again it must be gradually introduced into the feed, and it should be wilted for twenty-four hours before feeding, and chopped up or pulped. It should never be fed frozen. If excessive quantities are fed it causes acute indigestion and scour.

Gunning describes how he used a surplus of apples for pig feeding. Pregnant gilts were fed gradually at first, increasing to about 20 lb. a day with 1 lb. of meal fed twice daily in the dry state, and gradually building it up as the pregnancy proceeded. The gilts were kept at grass on a pasture that was worn out. Pigs running in an orchard where apples were plentiful selected only the best. Even the little piglets will nibble apples. Most fruits can be fed to pigs provided one starts with a small quantity, gradually building up to a moderate amount. Bringing pigs suddenly on to any fruit in the feed, or even a complete change of the protein in the ration by substituting foods like fish meal for ground-nut meal, will cause diarrhœa in young animals. Pigs under eighteen weeks old are particularly susceptible to sudden changes in the food, and deaths have been caused by frosted fruit feeding, frosted cabbage, turnips, or the feeding of indigestible material.

Pulped swedes, chopped mangolds, etc., can also be used to supplement a low meal ration, and again care should be taken to avoid feeding frozen roots, which are apt to cause an acute enteritis, followed by the death of the animal.

Mangolds are high in nitrates which may be converted to nitrites by the cooking process or by bacterial action in the animal body. As there is a rapid fall in the nitrate content during storage, mangolds should have been pitted for at least six weeks before feeding to swine.

Peanuts, if fed without a supplement of calcium carbonate and cod-liver oil, result in poor growth, inappetence and un-

thriftiness, whilst cottonseed cake contains an active poison which can be rendered harmless by heating. (See "Cottonseed poisoning.")

Acorns can be fed to fattening pigs in substitution for part of the ration of meal. The acorns should be thoroughly dried until the shells can easily be parted from the kernels. The substitution should be gradual, and according to the Ministry of Agriculture it is safe to give up to 1 lb. per day for a fattening pig.

Lawn grass cuttings have been used to a certain extent to replace some of the meal in pig feeding. Some authorities claim that they can use as much as $1\frac{1}{4}$ lb. of young leafy grass cuttings to replace 1 lb. of meal for weaned pigs. The superiority and rapid fattening qualities of meal-fed pigs over the grass-plus-meal variety is known, and detailed experiments carried out by Woodman and Evans showed that at least 7 to 8 lb. of fresh grass were really required to replace 1 lb. of meal, and in certain periods well over 20 lb. of grass was fed for every 1 lb. of meal saved. Whilst grass cuttings can be utilized by young pigs for growth and fattening, its use does not suggest any very great saving in meal.

Dried grass, which has now come into fairly extensive use as a supplement to the diet of animals, may be usefully included in pig food, up to about 3 per cent. of the ration.

The Lehmann Feeding System.—Under this system pigs have been fed on a basic ration consisting of some high-quality foods which are sufficient to provide the pig with all its needs for the proper maintenance of the body in good health, and this basic ration is supplemented with some bulky foods for fattening purposes. The bulky foods have a lower energy value, and may consist of potatoes, pulped mangolds, swedes, cabbages and kale, sugar-beet pulp, sugar-beet tops, silage, green lucerne, broccoli, green-pea haulms, etc. The method consists in feeding 1 kilo or about $2\frac{1}{4}$ lb. of the basic ration, and supplementing with the bulky foods. The basic ration should consist of about 70 per cent. cereals and 30 per cent. protein substances. The pigs are placed on this system when they weigh about 50 lb. (live weight), and it is claimed that the amount of meal used to produce a bacon pig may be reduced by as much as 50 per cent. under this method of

feeding. A basic ration may consist of weatings, barley meal and maize meal, or fish or soya-bean meal. Potatoes boiled and fed as a supplement appear to give better results than green food, and whilst the time taken to feed to bacon weight may be prolonged somewhat, and the finished pig may have a bigger frame, the quality of the meat is not altered.

Many interesting investigations into the whole vast problem of pig feeding have been and are continually being carried out. In BritainDr. Braude and his fellow workers at Reading University, and Lucas at the Rowett Research Institute, in Scotland, are particularly noted for this work, and numerous valuable publications on pig feeding are available from those sources.

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Chapter 5

DENTITION, HEALTH AND RESTRAINT

The Skeleton.—The *vertebral column* or backbone of the pig consists of five anatomical groups of bones extending from head to tail. The neck bones or cervical vertebræ are seven in number, the thoracic or dorsal vertebræ number 14, the lumbar or loin group are six. Next follow the five sacral vertebræ all fused to form one " sacrum." The tail or coccygeal vertebræ number from 18 to 20. There are usually 14 pairs of *ribs*, but 15 pairs are often found in some breeds, and in exceptional cases 16 and even 17 pairs are encountered. The ribs are said to be true and false. There are usually seven true ribs joined to the sternum or breast-bone below, by means of a prolongation of cartilage. The false ribs do not join directly to the sternum, but each cartilaginous prolongation is joined to that of the rib in front. The *sternum* consists of six pieces of bone (sternebræ) separated from each other by cartilage or gristle in the young animal. As the animal ages tbe cartilages tend to change into bone, and this ossification of cartilage in the animal skeleton assists the surgeon at post-mortem examination in enabling him to estimate the age of the subject The sternum, ribs and backbone then form the " barrel " to protect the vital organs in the chest cavity.

The *skull* is made up of the facial and cranial bones. The facial part is rather long in some breeds, and short in such breeds as the Middle White and Berkshires. The snout has a small bone to strengthen it for use when rooting. Air sinuses exist to lighten the skull and aid in strengthening the whole structure. The cranial cavity houses the brain, beneath which on a small stalk is the important pituitary body vitally concerned with growth and various body functions. From the brain the spinal cord runs down the backbone, well protected in the spinal canal of the vertebral column. Various important nerves are given off from the base of the brain and from the spinal cord. The lower jaw or mandible is strong and powerful in the pig.

Teeth.—The adult pig has forty-four teeth, whilst the temporary teeth total thirty-two. The dental formulas may be expressed as follows:

$$\text{Adult pig:} \quad 2\left\{ \text{Inc. } \frac{3}{3} \text{ Cn. } \frac{1}{1} \text{ Pm. } \frac{4}{4} \text{ Mlr. } \frac{3}{3} \right\} = 44$$

$$\text{Temporary teeth:} \quad 2\left\{ \text{Inc. } \frac{3}{3} \text{ Cn. } \frac{1}{1} \text{ Pm. } \frac{4}{4} \right\} = 32$$

Inc. = incisors; Cn. = canines or tusks; Pm. = premolars; Mlr. = molars.

The upper incisors are small, and are separated from the canines or tusks by a good space. The lower incisors are almost horizontal, convergent, and are closer together than the uppers. Of the upper incisors the central is the largest, the lateral central being shorter, and the lateral still shorter. The central lower incisor together with the lateral central are about the same size, whilst the lateral is shorter and somewhat flattened, with a short narrow crown and a distinct neck.

The canines or tusks are greatly developed in the male, but smaller in the female. In the male they project outside the mouth and may be from 3 to 4 inches long, curved, and the lower often has a sharp edge due to friction between the two tusks. They are often cut short in the boar to prevent injury to other animals. The tusks are permanent pulp teeth in pigs, and thus capable of continued growth.

The cheek teeth are seven in number on either side of the upper and lower jaws. The first four are known as the premolars, and the last three as molars. They are bunodont teeth with short crowns, distinct necks and pointed roots, and they increase in size from the anterior to the posterior of the jaw. The first premolar is a small tooth, and in the lower jaw there is a distinct space between it and the other premolars. It is sometimes absent in the lower jaw, whilst it occupies a position close to the other premolars in the upper jaw. It has two roots, the other premolars having three or four roots each, whilst the molars have four roots, the anterior pair often being fused.

When the pig is two years old the central and lateral central incisors are level and show signs of wear, as do the molars. The third molar is free from contact with the angle of the jaw. The molars show considerable signs of wear as the animal

ages, but it is impossible to tell tbe age by the teeth alone after about two years. The general appearance of the teeth

TABLE OF TOOTH ERUPTION IN PIGS

Age.	*Incisors.*	*Canines.*	*Premolars.*	*Molars.*	*Total.*
Birth	4 lateral	4	—	—	8
1 month	4 central	—	2nd, 3rd, 4th	—	24
3 months	4 lat.-central	—	—	—	28
5 ,,	—	—	1st perm.	1st	36
8 ,,	4 lateral perm.	—	—	—	36
9 ,,	—	4 perm.	—	2nd	40
12 ,,	4 central perm.	—	—	—	40
15 ,,	—	—	2nd, 3rd, 4th perm.	—	40
18 ,,	4 lat.-central perm.	—	—	3rd	44

and of the animal must be taken into account, but as a rule one can merely class the animal as aged.

The Limbs.—The bones of the *fore limb* start with the scapula or shoulder-blade which articulates with the humerus to form the shoulder joint. The elbow joint is formed from the distal end of the humerus and the proximal end of the radius with the accompanying ulna, the olecranon process of the latter bone forming the point of the elbow. In the pig the ulna is well developed and extends the full length of the radius. There are eight carpal or knee bones, and below the knee there are four metacarpal bones, each carrying a digit, giving the pig four toes, corresponding with the second to the fifth finger of the human hand.

In the *hind limb* the pelvic bone articulates with the sacrum. The pelvis forms a short tube-like cavity in which are found the rectum, bladder, and part of the sex organs. The pelvic bones are six in number (three on either side), fused together in the adult to form one massive structure. The ilium is the bone joined to the sacrum, and its tuberosity can be felt in the living animal forming what is commonly called the "hip bone." The ischium forms the rear portion of the pelvis, and is known to butchers as the haunch bone. The anterior part of the pelvic floor is formed by the os pubis (the pelvic knob). The

hip joint is made up of the pelvis and the femur or thigh bone, with the usual ligaments, capsules and synovial fluid found in all true joints. The distal end of the femur carries the patella or knee-cap. The next long bone is the tibia, and the stifle joint is made up of the distal end of the femur, the patella and the tibia. The fibula is a thin bone which extends the full length of the tibia in the pig. At the distal end of the tibia and fibula is the hock joint, with the seven hock or tarsal bones. As in the fore limb, there are four toes.

The Organs.—The *heart* and *lungs* are the two chief organs found in the thoracic cavity or chest. The pig's heart is not

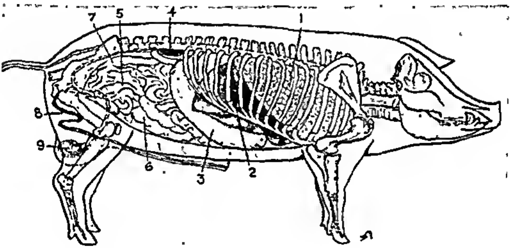

FIG. 37.—THE PIG. (MALE—RIGHT SIDE.)
1. Lung; 2. Liver; 3. Stomach; 4. Right kidney; 5. Small intestine; 6. Colon; 7. Rectum; 8. Urethra; 9. Testicle.

very big compared to the size of the animal. It has the usual pericardial covering, and the membrane is in contact with the sternum or floor of the chest from about the second intercostal space to the fifth rib. The aorta is curved and there is no common brachiocephalic trunk. The brachiocephalic artery arises from the aortic arch. The left lung has three lobes and the right lung four. Part of the thymus gland from the throat lies near the base of the heart, whilst the œsophagus or gullet passes through the thorax to penetrate the diaphragm and enter the stomach, the diaphragm being a strong muscular and tendinous curtain dividing the chest cavity from the abdominal cavity. It plays an important part in respiration,

particularly when the abdominal muscles are used in respiratory movements.

The *œsophagus* or gullet in the pig is comparatively short, and it passes through the diaphragm to enter the stomach obliquely in the median plane of the body about three or four inches below the twelfth dorsal vertebra. In an adult pig the *stomach* has a capacity of about 1½ to 2 gallons, and when it is full the greater curvature lies on the abdominal floor, transversely between the xiphoid cartilage of the sternum and the umbilicus. The large rounded portion of the stomach, with its blind pouch or diverticulum, is towards the left of the

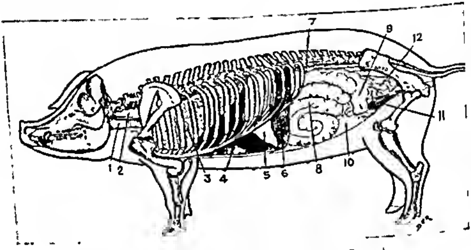

Fig. 38.—The Pig. (Female—Left Side.)

1. Trachea; 2. Œsophagus, 3. Lung, 4. Liver; 5. Stomach; 6. Spleen; 7. Kidney; 8. Large intestine, 9. Cæcum, 10. Small intestine; 11. Bladder, 12 Uterus

median plane. The right or pyloric part is smaller and is bent upwards to join the duodenum or first portion of the small intestine.

The *small intestine* varies from about 50 to 65 feet in length in the adult pig, and is held in the folds of the mesentery with its fat, blood vessels and lymph nodes. The first few feet or so of the small intestine are known as the duodenum, the middle part is the jejunum and the last part the ilium. This joins the *large intestine* at the iliocæcal valve in the cæcum. There is no appendix to the pig's cæcum, which forms a pouch-like structure and leads into the *colon*. This is coiled around or

itself and occupies most of the abdominal floor in the living animal. The *cæcum* is found towards the upper part of the left flank in the live animal, and it runs downwards towards the medial plane. The large intestine is about 12 feet long and is much wider than the small intestine. It terminates in the rectum, which leads to the anus.

Other important organs found in the abdominal cavity include the *liver*, lying between the diaphragm and the stomach; the *spleen*, which is a long strap-like organ attached to a lace-like curtain of fat—the omentum; the *omentum* is also attached to the curvature of the stomach, and the spleen is found on the left side of the abdominal cavity; the *pancreas* lies between the stomach, the duodenum and the liver.

The urinary *bladder* is found just in front of the rim of the pelvis when full. In younger pigs it is usually just within the pelvis. The two bean-shaped kidneys are beneath the transverse processes of the lumbar vertebræ, one on either side of the spine and the great blood vessels of the body. The tube leading from the kidney to the bladder is the ureter, which enters the bladder near the neck of that organ. The urine leaves the bladder through the urethra to the vulva in the female, and via the penis in the male animal. Alongside the kidneys are the important adrenal glands.

Sex Organs.—In the female the situation of the ovaries varies somewhat between the walls of the pelvis and the kidneys. The *uterus* of the sow has a short body but relatively long convoluted horns which look like a portion of small intestine in the young gilt. The *vagina* is about 6 inches long, terminating in the vulva, which has a thickened ventral commissure forming a pointed projection. In the pregnant uterus both horns contain embryos, embryotic membranes and fluid. About three weeks or so after conception the embryos are about 10 mm. or half an inch long. At 50 days they are about 80 mm. long (3 inches), and at birth about 9 inches from head to root of tail.

The uterus becomes important in determining if the animal concerned is a virgin gilt, or a sow, as the meat market price for these carcases varies considerably. In the gilt, the main branches of the middle uterine artery run a straight course

within the broad ligament. These branches are connected near the uterine wall by anastomosing arches, and from here small, straight-coursed vessels penetrate the uterine wall. In the post-gravid uterus of a sow the middle uterine artery is of much greater diameter, and its branches run a very convoluted course, as one would expect in an organ that has been very much enlarged, and has again shrunk. The short branches are also coiled, as are those in the uterine wall.

The *mammary glands* vary in number from ten to fourteen, and each teat has two tiny ducts. In selecting a young gilt for breeding it is important to notice the number of teats, and whether they are all in order. Occasionally one or two may be

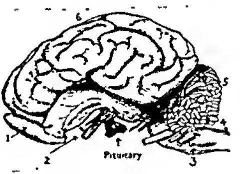

FIG. 39.—THE BRAIN OF THE PIG, SHOWING THE POSITION OF THE PITUITARY BODY.

1. Olfactory bulb (smell), 2. Optic nerve (sight), 3. Medulla; 4. Spinal cord, 5 Cerebellum, 6 Cerebrum.

involuted and useless. Breeding from gilts with about 14 teats usually means developing a long-sided animal capable of providing nourishment for 14 piglets, and the constant breeding of such animals will help to develop many commercial points in the breed.

In the male pig or boar the *scrotum* is not so pendulous as in the bull and other male animals. In adult boars the scrotal skin becomes very tough with age. The *testicles* are large, their axis being directed upwards and backwards, with the tail of the epididymis to the top The *spermatic cords* are long, and covering the neck of the bladder and the ureters are the massive vesiculæ seminales in the form of two three-sided pink

glandular structures. Beneath is the *prostate gland* lying over the neck of the bladder. The *bulbo-urethral glands* are two in number, being very large in the boar, and they lie on the urethra towards the posterior part of the pelvis. The boar's *penis* has a sigmoid flexure just in front of the scrotal region. The anterior part of the organ is twisted in a spiral. The average length of the boar's penis is about 18 inches.

Endocrine glands: Certain ductless glands in the body pour out their secretions into the blood stream and they have a profound influence on the growth, sex, appearance and vitality

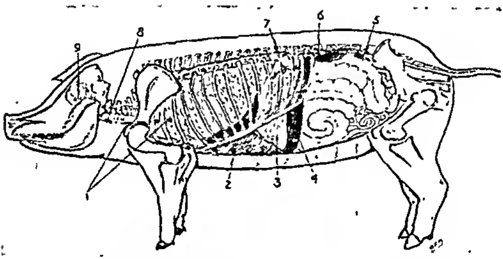

FIG. 40.—THE PIG, SHOWING THE POSITION OF THE GLANDS AND ORGANS FROM WHICH MEDICINAL EXTRACTS ARE MADE.

1. Thymus; 2. Liver; 3. Stomach; 4. Spleen; 5. Ovaries; 6. Adrenals, 7. Pancreas; 8. Thyroid and Parathyroids; 9. Pituitary body.

of the animal. The beneficial effects of these glands have long been known and use is made of them in medicine. Pharmaceutical and biochemists have succeeded in making extracts from large numbers of these endocrine glands, and they are in regular use both in human and animal medicine. A typical example is the substance made from the anterior part of the *pituitary body*. This little organ lies beneath the brain in a small cavity on the floor of the cranium, and it is attached to the brain by a short stalk. A substance called ACTH (adrenocorticotrophic hormone) made from this gland acts upon the adrenal glands, or suprarenal bodies as they are sometimes

called, lying near the kidneys. This ACTH helps the adrenals to produce cortisone, which has had such a remarkable effect in rheumatism, arthritis and such diseases. The posterior pituitary lobe produces other hormones also used medicinally in shock treatment, childbirth and other conditions. In all the pituitary body produces numerous hormones, although it is only the size of a small pea. Thousands of these organs have to be obtained to produce even one ounce of extract. Interference with the function of the pituitary produces gigantism, acromegaly, dwarfism and cretinism. The *adrenals* produce adrenaline, a substance much used again in rheumatism, shock, hæmorrhage, lumbago and arthritis. Lying near the larynx in the neck are the *thyroid glands*, in which are embedded the *parathyroid glands*. Extracts from these are used in the treatment of lack of growth, cretinism, retarded mental development and goitre. Excessive activity of the thyroids can produce overfatness, and some extracts have been used for the rapid fattening of pigs by producing this excess thyroidism, although this is a rather foolish procedure as it can well cause permanent damage to the glands. Removal of the parathyroids may prove fatal, and their disease produces symptoms of nervousness and muscular tetanic spasms.

Lower down the neck and partly in the chest cavity is the *thymus gland*. This is what butchers refer to as the " throat and heart sweetbread " in cattle. It is seldom collected as butcher's meat in the pig, but is very nutritious and is of value in rickets. This gland balances the sex organs and tends to shrink and disappear as the animal grows older. It persists in castrated animals.

The *testicles* in the male and the *ovaries* in the female also produce hormones vitally affecting the animal. This is in addition to their functions of producing ova and sperm. Extractives from such organs are also used medically, as are extracts from the corpus luteum found on the ovary, the placental membranes, the pancreas or " belly sweetbread," the spleen, liver and stomach. Anti-anæmia factors are found in the liver and stomach, insulin and pancreatin from the pancreas, and pepsin from the stomach. Various lymph-nodes are also used, and chemists are constantly finding new uses for parts of the pig's body. Whole industries exist to

convert these organs and glands into medicinal extracts in both liquid and tablet form.

The Skin.—The skin of the pig varies in thickness from about 2 mm. to the extraordinary armour-like thickness of the skin over the shoulder in an adult boar. The long straight bristles are carried down the back over the spine from head to tail, whilst the shorter and more curled hair comes from the flanks and remainder of the body. The sebaceous glands in the carpal region are usually six in number, running in a line postero-medially on the carpus alongside the flexors. About six or seven skin lines, probably developed from embryonic folds, run from each teat in a dorsal direction to fade out about half-way up the flank. These skin marks are seen even in adult animals of both sexes. The subcutaneous fat is in two distinct layers, a superficial and a deep layer, and it occasionally happens that a membrane between these two layers becomes thickened and very pronounced, resulting in pockets being formed between the two layers of fat. These pockets are sometimes filled with liquid fat.

The following are the average weights of various parts of the pig, and they refer to a young pig of between 180 and 200 lb. live weight:

Head, intact with brain, tongue, eyes and ears	11 lb.	5 Kg.
Brain	5 oz.	142 g.
Pituitary body	6 grains	0·4 ,,
Larynx and trachea	4 oz.	113 ,,
Left lung	8 ,,	227 ,,
Right lung	14 ,,	397 ,,
Heart	8 ,,	227 ,,
Liver	3½ lb.	1589 ,,
Stomach	1 ,,	454 ,,
Spleen	5 oz.	142 ,,
Omentum	8 ,,	227 ,,
Pancreas	8 ,,	227 ,,
Kidney	8 ,,	227 ,,
Mesentery	1½ lb.	680 ,,
Small intestine	3½ ,,	1589 ,,
Large intestine	3½ ,,	1589 ,,
Cæcum	8 oz.	227 ,,
Colon	2½ lb.	1134 ,,
Rectum and anus	8 oz.	227 ,,
Testicle	8 ,,	227 ,,
Uterus and vagina	6 ,,	170 ,,

Ovary	1/6 oz.	4·7 g.
Urinary bladder	1½ ,,	42 ,,
Gall bladder	1/6 ,,	4·7 ,,
Adrenal body	1/8 ,,	3·5 ,,
Tonsil	½ ,,	14·2 ,,
Thymus	2 ,,	57 ,,
Blood	7 to 8 pints	15 litres

These weights are of the fresh organ weighed within an hour of being slaughtered, the stomach and intestines having been emptied of their contents. In commercial practice, and in the bacon industry in particular, it is customary to speak of offal, and the following table shows the offal weights per hundredweight of bacon in an average pig of similar weight to that from which the foregoing were compiled:

Head	10·33 lb.
Psoas muscles (tenderloin)	1·45 ,,
Kidneys	·42 ,,
Feet (below knee and hock)	3·03 ,,
Scapulæ	58 ,,
Other bones (vertebræ, etc.)	5 57 ,,
Diaphragm (pillars)	63 ,,
Peritoneal fat	3·87 ,,
Lungs, heart and liver	5·75 ,,
Stomach and large intestine	3·48 ,,
Small intestine	83 ,,
Mesentery	1·43 ,,
Rectum	·49 ,,
Trimmings	2 49 ,,
Total	40 35 lb. per cwt.

Health.—Temperature depends upon the circulation of the blood distributing heat through the body, and may be conveniently divided into external and internal temperature. The external temperature is that of the skin and extremities, and may be taken by feeling the ears with the hands, placing the hands between the thighs, under the elbows, or feeling the flanks and limbs. A dry nose indicates a febrile temperature.

In cases of internal congestion of blood and weak circulation the external temperature may be low, and one should pass the hands over the body and not rely merely upon one spot to obtain an indication of the external temperature.

The internal temperature is obtained by passing the ther-

mometer into the anus. If inserted into the vulva in the female the temperature registered may be a fraction lower than that registered in the rectum, except during periods of œstrus, when it may be a fraction higher than the rectal registration.

The normal average temperature of the pig varies from 101° to 104° F. About 102° F. is considered a fair average. It is usually higher in the very young than in old animals, whilst that of females may be slightly higher than males. It is believed to be at its maximum in the evening and its minimum in the morning, whilst the temperature may be slightly higher after feeding and lower after drinking cold water. Atmospheric temperature may also influence the body temperature to a slight degree.

It is often not possible to take the pulse measurement in the pig, and to obtain an idea of the rate at which the blood is being pumped it will be necessary to auscultate the heart itself. The normal pulse rate of the pig is said to be from 55 to 75 beats per minute, but as the pig is a very nervous animal, especially when handled by a stranger, this indication becomes very unreliable.

The normal respirations in the pig vary from 20 to 30 per minute, depending upon the temperature of the sty and the time that has elapsed since feeding.

In examining the pig for rate of respiration, it is best to approach the animal quietly. Steady examination from outside the pen, if possible, after allowing the pig to notice the presence of a stranger, will tell more about the actual respiratory condition. The pig is normally nervous, and sudden handling by a stranger will give a completely false picture to the observer. The mere presence of such a person, or even a familiar attendant, will cause an increase in the pulse rate. A quiet look over the pen wall gives time to observe the general condition of the pig, whilst the animal overcomes its initial excitement at the presence of a stranger. Should the pig be gravely ill, approach and handling by a stranger will make little difference to the pulse rate.

The pig in health should possess a moist nose, and the mucous membrane of the eye should not be at all congested. The ears and the skin generally should be warm. The tail is

carried high and is often curled. The bristles along the spinal region should fall backwards and be slightly raised from the skin. The appetite should be good and the animal always ready for its food. The fæces should be fairly firm in consistency, and about 1 lb. of solid excrement is voided daily, with from 2 to 3 pints of urine.

Restraint.—For the purpose of certain operations on pigs, and the application of medicinal treatment, various methods of restraint will have to be used. A pig may be considered seriously ill if it is not disturbed by the presence of a stranger, and it allows itself to be handled and medicaments given without a protest.

Medicines can be given in the form of liquid drenches, as tablets, pills or capsules, or in the form of electuaries or as powders in the food. Hypodermic and intramuscular injections may be given in certain cases, and these latter forms of giving medicines are the best methods to apply in the case of adult pigs. Giving powders in the food is an easy but somewhat unsatisfactory method. It is useful when a whole pen of pigs need treatment, but is not so satisfactory as the individual dosing of each pig. For young pigs medicines in tablet, pill or capsular forms are very useful and can easily be given by the pig attendant.

In the case of the smaller pigs, they may be caught individually and held by an attendant Larger pigs may have to be roped, or crushed against a wall or corner with a hurdle or gate. It is sometimes possible to inject serum into store pigs by crowding the animals into a corner of the pen by means of a hurdle held in position by attendants, leaving just sufficient room for the veterinary surgeon to stand in amongst the pigs. The pigs will generally raise their heads and the serum injection can often be rapidly performed, as the pigs are too crowded to allow of any movement when the needle is inserted. Such a method saves a lot of time where hundreds of animals have to be injected and, as is often unfortunately the case, help is very limited, and no "crush" or "stocks" ever seems to be erected on British farms. The farrowing crate can always be constructed to act as a useful means of holding a pig for injecting any vaccines and even giving a general anæsthetic.

Large sows and boars have to be restrained by putting a slip-noose around the upper jaw, and tying them to a strong fence or post, often aided by a hurdle crush.

It should not be a very costly matter, especially on large pig farms, to erect a crush to hold pigs for serum injections and other operations. Such a "crush" can be built of timber in the form of a cul-de-sac, getting narrower and narrower until there is room for only one pig. By slipping a "gate" in position behind, with sufficient room for only the pig's head to protrude through the front gate, the animal can be restrained. Release is obtained by removing the front gate and replacing same, then opening the rear gate and so allowing the next pig to enter. Various pig catchers are also marketed. These consist of a long pole with a tongs-like end, one arm of the pincers being worked by a line from the operator's hand. The Dutch pig traps used in some abattoirs would also be very useful, especially the modified types with parts of the sides cut out to enable the operator to obtain access to the head and shoulders of the pig. Such traps take the form of "troughs" whose bottoms fall out under the pig's weight, leaving the animal held entirely by pressure against its flanks. The animal is released by rolling the trap over on its side, when the pig falls out on to the floor.

Anæsthesia.—For anæsthesia, chloroform and ether or A.C.E. mixture can be used, and also Nembutal in doses of $\frac{1}{8}$ grain per lb. body weight, given *per os* in capsular form, after a preliminary fasting period.

Professor Wright's method is to give $\frac{1}{8}$ grain of Nembutal per lb. body weight injected as a 7 per cent. solution into one of the small veins of the earflap. In large pigs the dose is [illegible] grain per lb. A warmed 2 per cent. solution of Bayer's Tutocain with suprarenin may be injected at the lumbosacral space for epidural anæsthesia.

Intravenous injections may be made into the *anterior vena cava*. The same site is ideal for the taking of blood samples, particularly where large quantities of blood are required for analytical purposes. Small pigs are restrained on their backs with their heads extended, and forelimbs flexed and abducted. Large pigs are restrained in the standing position with the head slightly elevated. In the hands of an experienced veterinary

surgeon this technique is comparatively easy and without hazard.

Phenobarbitone sodium in a 4 per cent. solution intraperitoneally in doses of 1 ml. per kg. of body weight (25 mg. of phenobarbitone per kg.) was used by Roux and Guillet for the operation of castration on 16 boars of 15 months of age, weighing from 70 to 90 kg. The dose was later altered to give from 29 to 30 mg. per kg. of the barbiturate, as only a basal narcosis was obtained from 25 mg. Thiopentone sodium was used for a similar operation on a 200 kg. boar. A 5 per cent. solution was injected intraperitoneally after fasting the animal for 36 hours, the dosage being 25 mg. per kg. body weight, and this gave a basal narcosis, the dose being repeated within ten minutes of the first. This causes a more profound narcosis eight minutes later, but without any muscular relaxation, nor was there much loss of sensitivity. The operation was proceeded with, and there was some reaction during the incision and crusbing of the cord. After the operation the animal could not stand alone, and remained drowsy for about two hours. Roux and Guillet suggest that a dose of 30 mg. per kg. would be necessary to obtain adequate and prolonged basal anæsthesia. The onset of the drug was rather slow after intraperitoneal injection, and the amount of peritoneal fat would no doubt influence this. The intraperitoneal route is easy and convenient in these large and sometimes dangerous boars, but the dose should be varied according to the condition of fatness of the animal. A larger dose than that described here would be needed to bring about a greater decrease in sensitivity and muscular relaxation. Post-operative complications were not noted, apart from some degree of thirst in the animals. They appear to tolerate these barbiturates well.

For cryptorchidectomy, Johnston used phenobarbitone sodium intraperitoneally, 1 ml. per 4 lb. body weigbt, with ropes tied to the hocks to raise the animal's hindquarters, so as to clear the intestines from the site of operation. Gunning used chloral hydrate in a 5 per cent. solution, giving 3 ml. per lb. body weight. This gave anæsthesia in from 20 to 30 minutes, and lasted for 1 to 1½ hours. Thiopentone sodium has also been used, in a 5 per cent. solution injected into an ear vein. For a hundred pound pig 10 ml. is injected rapidly, and 10 ml.

slowly. After 17 ml. full surgical anæsthesia is obtained, and this lasts for about 20 minutes (Glover). This substance must not be used intraperitoneally. Lakin used Xylotox epidurally, for pigs up to 70 lb. weight, at the rate of ½ ml. per 10 lb. body weight.

Chlorpromazine has been used by Ritchie as a 5 per cent. solution by the intravenous or deep muscular route. The intravenous dose is 0·55 to 33·3 mg., per kilogram body weight. There is no irritation, nor is there any difference noticed with slow and fast injection. The squealing ceases, and the respiratory rate increases within 1 or 2 minutes, gradually slowing down to normal in some 15 minutes. The head is slowly lowered, and the animal sinks into a deep sleep. Boars do not respond so well, and tend to show violence.

The castration operation upon large boars needs complete anæsthesia. In many cases the animals are aged boars which have finished their life as sires and it may be necessary to remove the testicles so as to fatten up the animal and lessen the distinctive boar odour in the meat after slaughter. To one who has performed this operation upon such animals many times the simplicity of the intraperitoneal route for giving the anæsthetic makes a great appeal, although many boars would have to be restrained with ropes around the upper jaw tied securely to some post before one could even make a simple injection. Hitherto I have preferred the more lengthy and leisurely method of applying a general anæsthetic of ether through a nasal mask. It takes longer, and the animal needs to be well secured, whilst the quantity of anæsthetic required is often surprisingly large in some of these enormous pigs. The result, however, is complete anæsthesia and muscular relaxation, which lasts sufficiently long to enable the slowest operator to complete the job. Fibrous adhesions between scrotum and testes are sometimes encountered and they need great patience and skill on the part of the surgeon for their removal. That is where complete anæsthesia is valuable. These large boars recovered in from 15 to 30 minutes from such deep anæsthesia.

The electric stunner as used for the pre-slaughter stunning of pigs in abattoirs was used by the author as a form of anæsthetic for the operation of castration in adult boars as long ago as 1932, and such operations upon three boars were wit-

nessed by Professors Symes, Sir Leonard Hill and Sir Frederick Hobday and reported upon in the *Veterinary Record*. As the operator concerned, the author stressed both in 1929 and again in 1932 the possible danger of violent muscular spasms resulting in bone fractures in the patients. Whilst electricity may be useful for small operations lasting only a matter of a few minutes, it is too risky a method for general adoption where an uninterrupted recovery is required. For slaughter animals the position is totally different, the modern use of rapidly applied currents of 80 volts or less to the head, so that the brain is in line with the electrodes, has wiped out the spinal bone fractures of the earlier pioneer days and has made the electric stunner an invaluable aid to humane slaughtering.

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Chapter 6

THE SCHEDULED DISEASES

THE so-called "scheduled diseases" are rinderpest or cattle plague, anthrax, glanders, rabies, foot and mouth disease, epizoötic lymphangitis, parasitic mange of horses, asses or mules (certain forms only), contagious bovine pleuro-pneumonia, sheep pox, sheep scab, swine fever, certain forms of bovine tuberculosis, fowl pest and atrophic rhinitis of pigs. These diseases are scheduled under the Diseases of Animals Act of 1894 and subsequent Acts and Orders for control and eradication from this country. The Diseases of Animals Acts empower the Minister of Agriculture and Fisheries to issue orders from time to time in respect of these diseases, but of the conditions mentioned only five are regarded as being likely to affect pigs —viz. anthrax, rabies, foot and mouth disease, swine fever and atrophic rhinitis.

Anthrax.—This disease is also sometimes known as splenic fever or apoplexy, melt or milt disease, St. Anthony's fire, and murrain. (The latter term is one used in the remote past, and this condition is believed to be one of the Plagues of Egypt, but the term murrain was often used for plagues in general.) Another name for the disease is "Cumberland disease." In France it is known as charbon. In man the disease is called malignant pustule, or woolsorter's disease, according to the nature of the symptoms.

Anthrax affects all the domestic animals and man, although the ox is the animal most commonly affected. The cause of the disease is the *Bacillus anthracis*, a large non-motile rod, from 5 to 10 μ long and 1 to $1\frac{1}{4}$ μ broad. In cultures it frequently forms long threads or filaments. It is aerobic and in the body grows as a facultative anaerobe. In fairly hot climates the bacillus can live and multiply outside the animal body, but in the temperate climate of this country and in the presence of free oxygen the organism forms spores which remain alive in the soil for long periods. These spores can be destroyed

in hot air at a temperature of 284° F. for three hours, and in liquids for four minutes at 212° F. Mercuric chloride 1 : 1,000 will destroy the spores in a few minutes, and 4 per cent. carbolic acid with 2 per cent. hydrochloric acid will destroy them in one hour.

Infection in pigs occurs through the food as a rule, the infection being by spores, as the gastric juice is said to destroy the bacteria. Infection may also occur through wounds and scratches and by inhalation, but the latter methods usually occur in man rather than in the pig. The incubation period is short, and in laboratory animals death occurs in from twenty-four to thirty-eight hours after inoculation. The bacteria appear in the blood about fifteen hours after inoculation, and at death they are swarming throughout the blood everywhere. The organisms eliminated are from the body in the urine, fæces and mucous discharges, and by this means pastures may become infected. In America, season is said to be a contributing factor, the disease being most prevalent following a hot dry season after high spring floods. Anthrax may thus be said to be a typical bacteræmia, the method of infection in the pig being by the ingestion of infected material, or from contaminated pastures, by effluent from tanneries using anthrax cattle hides, carpet-works effluent, bristle works and meat by-product works generally.

According to Smith and Keppie, the overall pathogenicity of *B. anthracis* is due to the production in the host of an armoury of different substances acting individually or together. At least three important substances, all with aggressive activity, have been demonstrated. Two of these aggressins are intracellular, one of them, polyglutamic acid, occurring in the capsule. The third is produced extracellularly and is connected with the specific lethal factor which in anthrax causes the death of the host in secondary shock. A strain of the organism is only fully pathogenic when all the substances of the anthrax armoury are produced. The absence of one may result in the strain becoming relatively non-pathogenic although its capacity for producing the others is unimpaired.

Anthrax in pigs is not uncommon in the United States, and is said to exist enzoötically in certain parts of the country where it has been the practice to feed the carcases of cattle

to pigs. The feeding of imported bone meal, etc., from Eastern countries is said to be responsible for much of the disease in pigs in Germany. Three types of the disease are recognized—viz. the septicæmic or bacteræmic, the pharyngeal, and the intestinal. The intestinal type is regarded as the most serious from the point of view of animal and public health, as it is not often diagnosed, and meanwhile bacilli are being passed out in the fæces of infected pigs, and so cause a spread of the disease.

Diagnosis is made from the symptoms and by demonstration of *Bacillus anthracis*. Special attention is directed to the submaxillary, pharyngeal mesenteric lymph glands, and the peritoneal fluid. The bacilli are few in number, or else may be demonstrated in lengthy chains, granules, empty capsules, or clumps. In the septicæmic form especially it is necessary to demonstrate the presence of the organism so as to avoid confusion with acute erysipelas or swine fever.

Symptoms.—Pigs are said to possess a considerable resistance to anthrax infection, and it is rare to find the disease in them except from a direct infection from an anthrax carcase. A pig may be slightly off its food for a few days, with some rise in temperature, and that may easily be overlooked. After being off their food, and seeking warmth under their bedding for some days, this fevered condition is accompanied by vomition. Later the neck becomes swollen, and in some cases there may be a slight swelling between the hind-legs, the skin over these swellings being red in colour. Later, symptoms of diarrhœa and dysentery appear. Where there is a congestion of the lungs, respirations will naturally be accelerated. The urine becomes blood-coloured, and dyspnœa is followed by death from asphyxia. Natural recovery from an attack of anthrax is not unknown in young pigs. In the septicæmic or bacteræmic type, hardly any symptoms are noticeable. The usual story is of the animals being quite well at night, and found dead for no apparent reason when next seen on the following morning.

Post-mortem Appearances.—Carcases of pigs dead from suspected anthrax should on no account be opened. Where such carcases are inadvertently opened the blood will be found darker in colour than normal and it will not clot well,

and in the septicæmic form it may be possible to demonstrate the bacilli in the blood by microscopic examination. The enlargement of the spleen characteristic of the disease in the ox is not observed in the pig, the most constant lesion being the congested and gelatinous condition of the throat fat and the swelling and acute congestion of the lymphatic glands, as one would expect in a septicæmic or bacteræmic condition such as anthrax. In some cases vesicles are found on the mucous membrane of the mouth and tongue. These vesicles are filled with a bloody fluid. Inflammation of the mucous membrane of the respiratory tract, larynx, pharynx, and trachea is present as well as petechial hæmorrhages in the lungs and also in the subcutaneous tissues, and some œdema of the mesentery, with swelling of the lymph glands. There may also be some evidence of gastritis or gastro-enteritis. Where evidence of the latter is found the intestinal contents may be fluid and almost black in colour.

J. E. Saunders, reporting on some cases of anthrax, found the most constant lesions were inflammatory changes in the respiratory tract and stomach, and that where a local lesion is found in a mesenteric gland ascitic fluid is a prominent finding. He suggested that where a combination of such lesions is seen at a post-mortem examination a search should be made for the *Bacillus anthracis*. The organisms will often be so few in number as to be easily missed, particularly in the œdematous material surrounding a lymph gland.

Diagnosis.—The rapidity with which throat lesions develop, and the absence of the bowel lesions found on post-mortem examination, distinguish anthrax from swine fever. The skin hæmorrhages in anthrax are deeper-seated than those found associated with swine fever and swine paratyphoid, nor are they easily confused with the skin lesions of swine erysipelas, even in the acute stage. A gelatinous blood-tinged throat swelling is not found in the other diseases mentioned with the exception of swine erysipelas, when the swelling differs from that of anthrax in being sited around the base of the ears. The erysipelas swelling, when present in the site mentioned, is composed of a clear gelatinous fluid. In some cases of anthrax vesicles containing fluid are found on the tongue and mucous membrane of the mouth, and these may

lead to some confusion with foot and mouth disease lesions. In the latter disease lesions are also found on the feet, and the vesicles are generally filled with clear or straw-coloured fluid, whereas the liquid content is blood-coloured in anthrax. Both blackquarter and malignant œdema may be confused with anthrax in the pig, but the frothy nature of the blood in black-quarter may help to distinguish it from anthrax. In the latter disease the swellings are of a more gelatinous kind than the gaseous œdematous lesions found in blackquarter and malignant œdema. The septicæmic appearance of the carcase and organs in all these diseases makes it necessary to resort to the microscopic examination of blood and peritoneal fluid smears to demonstrate the organisms concerned.

Treatment, etc.—Suspected cases must be reported to the police, who usually have one of their officers detailed to act as Diseases of Animals Inspector for the local authority. The police notify the Ministry of Agriculture and Fisheries, who will then send one of their veterinary surgeons to investigate the matter. In the meantime, care must be exercised not to move the dead carcase nor allow other animals to gain access to it. The veterinary surgeon will take blood swabs from a superficial blood vessel or, better still, from the cut surface of a superficial lymph gland. He will also aspirate fluid from the peritoneal cavity. He will then make smears and examine microscopically for the *Bacillus anthracis*. Should his examination prove negative, the local authority will be notified at once. Should the surgeon suspect anthrax from his microscopic examination of blood smears, he will send a blood swab and some of the throat glands to the Ministry's veterinary laboratory for examination and confirmation or otherwise of his diagnosis. The local authority is notified in any case, and they must immediately arrange for the destruction of the carcase. Every suspected carcase should, if possible, be cremated on the infected premises, but if this is impossible its natural orifices must be plugged before removal of the carcase to prevent the discharge of blood containing anthrax bacilli and then sporulating in the presence of oxygen. The carcase should be carried on some improvised sledge if it has to be moved for destruction. Failing the possibility of cremation on the infected place, the carcase must be buried at a depth of at least 6 feet from the

ground surface, remote from a dwelling-house or water supply. A layer of lime 1 foot deep should be placed below and over the carcase and the place fenced in, or its surface covered with a layer of concrete.

Animals remaining alive on the premises will have to be examined, and all movement of animals restricted in a prescribed area. All infected litter, dung, fodder, etc., must also be burnt, and all buildings thoroughly disinfected, the disinfectants recommended being a limewash of quicklime and water containing at least 4 oz. of chloride of lime to the gallon, or ½ pint of carbolic acid to the gallon.

In countries where treatment of anthrax cases is carried out penicillin has proved invaluable. The restrictions dictated by the Anthrax Order will apply to all animals under treatment.

A vaccine alone or a combination of serum vaccine treatment may be used as a prophylactic. The feeding of carcases to pigs should be prohibited, as, owing to the existence of this comparatively benign form of the disease in pigs, control of the disease in other animals is rendered doubly difficult.

In South Africa anthrax spore vaccines have been used with satisfactory results. An improved technique was evolved for the preparation of these vaccines, and whilst most of the work was done on cattle, sheep and goats, laboratory tests on sheep showed that saponin considerably increased the immunizing power of ordinary vaccine strains. It was found best to use saponin witb mild strains to improve immunity, rather than to employ it for reducing virulence in strong strains. Sterne reported that a vaccine prepared from virulent (uncapsulated) variants retained its immunizing power for at least one year. Field tests carried out on 2½ million cattle, as well as thousands of horses and sheep, showed that this vaccine was safer and produced slighter reactions than ordinary saponin spore vaccine. Highly bred animals tolerate the inoculation well, and the cattle vaccine can be used on other animals. Antibiotic treatment has proved successful against anthrax, and penicillin is now generally used with excellent results.

Foot and Mouth Disease (or epizoötic aphtha, aphthous fever, eczema epizoötica) is a contagious fever attacking primarily cattle and all cloven-hoofed animals, and is charac-

terized by the eruption of vesicles in the mouth and feet. The disease is very contagious, and infection may be carried on the food, on litter, or on the clothing of animal attendants. Birds have also been suspected of carrying the infection to this country from abroad.

The cause of the disease is a virus which exists in the lymph from the vesicles formed in infected animals. Filtration experiments which permit of an estimation of the particles of virus show that of foot and mouth disease to be among the smallest (from 8 to 18 millimicrons, or one to two-hundredths the diameter of a small bacterium). There are three types of the virus, designated O, A, and C. Animals recovered from a natural infection are said to have a very short immunity, whilst immunity against one type of the virus does not protect the animal against the other type. Foot and mouth disease is one of the most rapidly spreading of diseases, the discharges from an infected animal being very infective. The virus is readily destroyed by formaldehyde, carbolic acid and other disinfectants. If not dealt with the virus may persist for some time in infected manure, straw, etc.

The method of infection is via the alimentary tract, and the disease may also be contracted by inhalation, the period of incubation being from one to ten days, with from three to six days as the commonest.

Symptoms.—Lameness is the chief symptom in the pig, and there is also an indisposition to eat, combined with a high temperature. The pig lies down a lot, and is not disposed to move about. There is some tenderness of the feet with some reddening of the skin next to the claws. A vesicle or blister of sero-albuminous fluid appears, raising the epithelium over the area. These vesicles burst, leaving a red smooth surface, and they may be found on the snout as well as the feet. If the animal is driven or forced to walk any distance, there may be a blood discharge from the open sore, and the horny claw may eventually come off the foot. The disease may run its course in two to three weeks, and leave the animal in a very debilitated and emaciated condition. It is not always fatal, but is said to be more so in the case of very young animals.

Diagnosis.—The feet lesions may sometimes be so severe as to cause the animal to move along on its knees, owing to

the severe laminitis set up. Vesicles are found on the coronary border, inside the mouth, on the tongue and hard palate, and in sows they may even be present on the udder. There is no throat swelling as in anthrax, nor are there any skin lesions as in swine fever, paratyphoid, and swine erysipelas. An ordinary case of stomatitis may be distinguished from foot and mouth disease by the absence of any foot lesions. The rapidity with which the disease spreads to other susceptible animals on the premises will point to foot and mouth infection.

Post-mortem.—It is forbidden in this country to make a post-mortem examination on a suspected case of foot and mouth disease, but where such an examination is inadvertently carried out, the only lesions encountered in the pig will be those of the feet—viz., vesicles and sore places around the claws. If the animal is examined after death during the febrile stage, some congestion of the lymph glands will be noticeable, and the usual appearance of a fevered carcase. The mouth lesions are very rarely found in pigs.

Treatment, etc.—As this disease is scheduled, no treatment is permitted in this country. The disease, if *suspected*, must be reported to the police at once, who will take steps to have the matter investigated by the Ministry of Agriculture and Fisheries. The Ministry's veterinary surgeons diagnose the condition, and police measures are taken as in anthrax. The infected animals are cremated on the infected place, whilst in-contacts are slaughtered, and non-susceptible animals such as horses, dogs, poultry, etc., are prevented from approaching the spot. A restriction of movement of animals over a wide area, generally within a radius of fifteen miles from the infected place, is at once put in force, with a very severe restriction closer to the site of infection. All manure, litter, etc., is disinfected or burnt, and buildings are also thoroughly disinfected and kept empty of susceptible animals for some time. Every effort is made to stamp out the disease. Compensation is paid to the owner by the Government. Enquiries to trace the source of the infection are carried out by the Ministry in all cases, and this applies to all the scheduled diseases.

The drastic powers of the Ministry in this respect are exemplified in the embargo placed on all importations of foreign

pork carcases in 1926, following upon a particularly heavy infection in this country. Numerous cases were discovered in pork carcases imported from certain continental countries, and the Ministry's embargo completely destroyed that trade, nor has the embargo been raised to this day. Under the Foot and Mouth Disease (Boiling of Animal Foodstuffs) Order issued by the British Minister for Agriculture, all swill must be boiled for at least one hour before it can be fed to pigs. Packing material used in the imported meat trade, etc., must not be allowed to come into contact with farm animals. The Ministry also issues orders prohibiting the holding of markets, hunting, the disposal of slaughter-house manure and offals, the cleansing of transit vehicles, and the licensing of the movements of animals.

There is no doubt that, in spite of ill-informed criticism, the slaughter policy has saved this country an enormous expense. It is better to have an occasional outbreak of the disease and to stamp it out at once, even if such a method is costly, than to have foot and mouth disease established, as it once was, as indigenous to this country, and causing a great wastage in our animal population. Our island position is favourable to the complete eradication policy.

In some countries it has been found impossible for various reasons to adopt a slaughter or complete eradication policy, and attempts are made to immunize animals against the disease, but owing to the varying types of virus this method has not been very successful. Hyperimmune serum has also been used, but as yet an effective vaccine has not been produced. The disease is not often very fatal, and lesions respond to treatment with mild antiseptics, foot baths, etc. The spread of the infection is so rapid that in some countries it is accelerated by actually rubbing infective material from one animal to the other so as to get the disease over quickly, the hyperimmune serum treatment being used at the same time.

In America a vesicular exanthema of pigs has been encountered in which are found lesions similar to those found in pigs affected with foot and mouth disease. This exanthema is said to be caused by feeding on garbage, and a virus has been implicated. The virus can be distinguished by biological reactions from that of foot and mouth disease.

Swine Fever (hog cholera or pig typhoid, Schweinepest, or peste du porc) is a disease of pigs of all ages caused by a filtrable micro-organism existing in the blood, the internal organs, the eye and nose secretions, and urine of infected pigs. The disease is complicated by infections with secondary invaders, notably *Salmonella suipestifer* (*Salmonella choleræsuis*) which are found after death in the blood and organs of the majority of pigs dead from swine fever. The *Salmonella* organism is a small, actively motile, non-spore-bearing bacillus with rounded ends, staining readily with the ordinary aniline dyes, and is Gram negative. The swine-fever virus itself is regarded as one of the smallest of the filtrable micro-organisms. It is very resistant to destruction by disinfectants, but is destroyed by boiling. Alkaline soap solutions of cresol will, however, destroy the virus, a 3 per cent. composite solution of cresol being effective. A 5 per cent. solution of Antiformin is also said to be useful in destroying the virus. Any agency which is capable of carrying some dirt from infected pig pens will serve as a means of spreading the disease. Lice (*Hæmatopinus suis*) on the carcases of dead swine-fever pigs have been shown to be carriers of the virus, transmission occurring by ingestion of the lice, or by their passage from infected carcases to the skins of healthy animals.

The virus is present in the body throughout the course of the attack, and is found in the body fluids in the incubation period, being present in the discharges, notably the urine. It is thus soon spread. Outside the animal body the virus is said to be very tenacious, but succumbs easily to putrefaction. Carbolized virus, kept at low temperature, has been known to survive for three years, whilst it has been found in cured hams from infected pigs. In the chronic form of swine fever the blood may be free from virus.

Another secondary invader often present in swine-fever cases and said to be responsible for the lung lesions is *Pasteurella suiseptica*, the organism associated with so-called swine lung plague.

The common method of infection is by ingestion, and apparently healthy pigs may act as carriers. The disease is widely disseminated throughout the civilized world, and may be carried by infected pigs to markets, railway waggons,

lairages, etc., whilst animal attendants, rats and birds are said to act as mechanical carriers of the virus.

Pigs purchased in open market and brought into a herd are frequently carriers of infection, especially if they are brought into direct contact with the herd pigs without any isolation period. Pig castrators have also been accused of transmitting the disease from farm to farm. Uncooked garbage is regarded as a source of infection. Under natural conditions the disease is rapidly spread, although experimental transmission of swine fever is not always easy. It is most prevalent in the late summer and autumn in the U.S.A., but outbreaks occur in the Southern States all the year round. Although pigs from immune sows are said to be born with an increased resistance against swine fever, they can contract the disease before they are a month old. Losses from this disease are heavy both in Europe and America, and the control measures in force in various lands appear to have done little towards its elimination.

Symptoms—Acute Stage.—In swine fever we are dealing with a septicæmia, and although there may be an incubation period of from five to ten days, a sudden death amongst the pigs is often the first sign of anything being radically wrong. In investigating illness among a herd of pigs a history of hogs dying suddenly, the appearance of diarrhœa, general unthriftiness, and the presence on the premises of a lean razor-backed old breeding sow should serve as pointers to the existence of swine fever. Examination of ailing pigs will reveal a temperature of between 105° and 108° F. Animals are obviously indisposed, listless, with hollow flanks, and the gait may be staggering. They tend to burrow under the bedding or huddle together. A purplish discoloration of the ear-tips is noticeable, and this colour may extend towards the shoulders, along the belly, and in some cases down the back to the hams. Small areas of necrosis may be found on the ear-tips, vulva, and on the legs below the knees and hocks. Small pieces of skin on the leg lesions may slough off, leaving circumscribed ulcers about 1 centimetre in diameter. Ailing pigs resent being moved, and appear weak in the hind-quarters. A primary constipation is followed by yellow-stained diarrhœa, which may later be blood-stained. The eyelids appear as

though stuck together, due to the mucopurulent discharge resulting from a conjunctivitis. Snuffles or nasal discharge often accompanies this condition, with some coughing and abdominal breathing where pneumonia symptoms are present.

FIG. 41.—PNEUMONIA ACCOMPANYING SWINE FEVER.
The carcase shows fine skin hæmorrhages and bite marks show up very prominently.

The temperature fluctuates and becomes subnormal as death approaches. The disease runs its course in about a week, and mortality is often very high. Survivors either completely recover or pass into the chronic stage of the disease.

In the *subacute* or *chronic stage* there is evidence of a

general depression and unthriftiness amounting in some cases to emaciation, with or without diarrhœa. Symptoms of pneumonia, with the skin discoloration previously described, are sometimes noticeable. In other cases, apart from general unthriftiness and emaciation, there may be few typical symptoms. This type of the disease is often seen in older pigs and sows, and there is usually a history of pigs dying from a wasting disease.

Post mortem.—As has already been mentioned, in dealing with swine fever we have a septicæmia plus lesions caused by a secondary invader. For years, in discussing the disease, it was customary to devote particular attention to the bowel ulcers in the cæcum and around and about the ileocæcal valve, but it is now recognized that there exist more characteristic post-mortem lesions of swine fever. These are petechial hæmorrhages in the skin, mucous membranes, serous membranes, the bladder, and particularly underneath the kidney capsule. Infarcts in the spleen and patchy hæmorrhages on the cæcum as well as portions of the colon are found. The carcase lymph glands are usually very congested, almost black in colour, most noticeable even before they are incised. On section, the glands show a peripheral congestion with very dark blood. Subcutaneous hæmorrhages in the skin may be masked by a covering of bristles and dirt, and it is advisable in carrying out the examination to wash a portion of the skin surface and scrape off the bristles with the superficial layer of the epidermis, so as to expose the hæmorrhages. These may take the form of patchy, pin-point hæmorrhages over the back, hams, belly and shoulders, almost black in colour, or the colouration may extend to an even colouring of a brighter red all over the carcase, particularly involving the ears, back, and hams. These are the type referred to by butchers as red soldiers. It is characteristic of the disease, being a septicæmia, that any bruises or bite marks on the skin will show up after death, not as red weals but as black markings. The lungs show hæmorrhages, and even an extensive pneumonia with grey hepatization and necrosis may be present. Dark red consolidated areas which are found in the lungs have been described by Pattison as showing the histological picture of atelectasis. Cranial hyperæmia and some hæmorrhages on the

epiglottis are also found. There is some alteration in the blood composition, the most characteristic change being a leucopenia with a diminution in the blood platelets and an increase in the lymphocyte count.

The portion of the ileum nearest the cæcum shows a diphtheritic inflammation, the stomach lining is inflamed, petechial hæmorrhages are found in the small intestine, and the button ulcers may be present in the cæcum, sometimes extending into the contiguous part of the large intestine. These ulcers are slightly raised by a cover of thick deposit

FIG. 42.—SWINE FEVER ULCERS ON SECTIONS OF SMALL INTESTINE.

arranged concentrically, or else they are shallow, due to the contents and covering having been removed.

In the more chronic form of the disease hæmorrhages may not be present. Carcases are often emaciated, the spleen is smaller than normal, button ulcers are present in the large intestine, with some tiny ulceration of the bladder mucosa. Lesions of pneumonia or pleurisy accompany the fever.

Diagnosis.—Diagnosis is not easy in the early stages of the infection, and the tendency to regard the cæcal ulceration as diagnostic of swine fever has resulted in many cases of swine paratyphoid or necrotic enteritis being mistaken for the virus

disease itself. It is, of course, not possible to arrive at a correct diagnosis of any disease unless one takes into consideration *all* the symptoms, and in the case of swine fever particularly all the post-mortem lesions as well. It is thus often necessary to slaughter an ailing pig, and conduct a post-mortem examination thereon, in order to distinguish between swine fever and other diseases. For that reason it is just as well to recapitulate the main lesions one expects to find at a post-mortem examination of a pig dead from swine fever.

Emaciation may or may not be present. A careful search should be made for skin discoloration and hæmorrhages—if necessary, scalding a portion of the skin and scraping off some of the bristles and superficial epithelium. The lymphatic glands should be examined and will be found very congested and dark in colour. In the early stages of the disease the congestion is usually in the cortex of the gland. There will be blood extravasations in the lungs, and often pneumonia, whilst the heart, stomach and bladder also show extravasations. Petechial hæmorrhages are present on the outer and inner aspect of the intestines, with ulceration in the cæcum. In acute cases the spleen is enlarged slightly and somewhat congested. The fæcal contents of the cæcum are often black in colour. Encephalitic lesions may also be found in the form of a marked congestion or hæmorrhages in the brain, and some continental authorities maintain that this lesion gives the only certain indication for a diagnosis of swine fever.

Other authorities regard the spleen infarcts as characteristic, whilst others swear by the kidney hæmorrhages, but in general the picture we get is one of septicæmia, and insistence upon one particular type of lesion as being diagnostic of this disease is fundamentally wrong. In England the bowel ulcer has long held its ground as a characteristic swine fever lesion until the continued growth of pig herds in pre-war years resulted in overcrowding in hurriedly erected and often badly ventilated Danish pig-houses. This brought in its trail attempts to feed for market in record time, with a minimum of food—the so-called "scientific feeding" era; the whole resulting in the spread throughout English herds of necrotic enteritis in particular, to say nothing of swine influenza, anæmia, scour and the usual deficiency diseases. The wider

scope for swine-rearing in America had also resulted in a crop of similar diseases, and the greed of English breeders in overstocking their herds thus merely brought English veterinary surgeons closer to a disease (necrotic enteritis or pig paratyphoid) already known to their American colleagues.

The disease may be differentiated from swine erysipelas, as there is no cæcal ulceration in the latter disease, whilst the skin discoloration is often more extensive or occurs in the characteristic "diamond" shaped raised red patches. Petechial hæmorrhages in the skin are not usually found in erysipelas, nor are the lymph glands so pronouncedly hæmorrhagic. There is an absence of pneumonia and of kidney hæmorrhages. In erysipelas the limb joints may be enlarged and the iliac lymphatic glands are often very much enlarged and of a brownish colour. Swine erysipelas seldom attacks very young pigs, old sows and boars. It is usually more rapid in its onset and the pigs have a tendency to lie down quite a lot, whereas swine fever does not appear so suddenly, and affects pigs of all ages.

Both Aujesky's disease and Teschen disease may be distinguished from swine fever by the absence of splenic and renal infarcts, hæmorrhages, and lymphatic gland hæmorrhagic infiltration. Whilst swine influenza may carry pneumonic lesions, there is an absence of the bowel ulceration found in swine fever.

Undoubtedly the disease most often confused with swine fever is pig paratyphoid or necrotic enteritis, in which the organism implicated is the *Salmonella suipestifer*, which is a secondary invader in swine fever. In paratyphoid it is usually the young pig that is affected; in adult pigs the infection of paratyphoid is so mild as to pass unnoticed in the living animal, and the only lesions found are at a post-mortem examination in dressed carcases in abattoirs (*i.e.* carcases that have been scalded and scraped so that the tiny skin hæmorrhages become visible). Paratyphoid is usually found during the winter months, whereas swine fever may affect pigs during any period of the year.

The kidney hæmorrhages in paratyphoid are not so numerous as in swine fever, and may often be missing altogether, whilst the skin lesions also are not always so extensive. In

paratyphoid there may be present a yellow diphtheritic film covering the intestinal mucous membrane in parts. The intestinal ulcers are not confined to the cæcum, and are not so raised in appearance above the mucous membrane, nor are they of the button type as in swine fever. In paratyphoid there is a distinct line of demarcation around the ulcer.

Encephalitis is more marked in swine-fever virus infection than in paratyphoid, but histological examinations are not sufficient to distinguish the two.

There is a difference in the general appearance of the carcases in the two diseases. A pig carcase affected with swine fever shows the picture of an acute septicæmia or bacteræmia, whereas one affected with paratyphoid tends to give one the impression of a milder infection in which the skin and kidney lesions are often absent or difficult to find; whilst the fæces in swine fever are often black in colour in the cæcum, in paratyphoid they are more of a yellowish tint. Pneumonia may not be associated with paratyphoid, whereas it often accompanies swine fever.

Methods of distinguishing swine fever from paratyphoid have been carried out in Russia, whereby the urine of infected pigs is dialysed and filtered, and used with serum from rabbits which had been inoculated with the urine of infected pigs. Urine contains a high concentration of virus and little protein, which appears to inhibit the antigenic properties of the virus. Dialysis of the urine renders it non-toxic to experimental animals. Results are said to be specific.

Another test is the modified intradermal Sarnowiec test, whereby blood from a suspected pig, plus castor oil, is injected into the dermis of a known immune pig. The reaction is tested by measuring the skin before and twenty-four hours after the injection. It is claimed that healthy pigs do not react to this test.

The gel-diffusion precipitin test, from the pig pancreas, is also being developed as a specific test for swine fever.

Treatment.—Preventive treatment consists in avoidance of overcrowding, isolation of fresh swine before introducing them into the herd, and in providing the animals with the necessary care and attention. Attention must be paid to hygiene,

proper feeding, breeding, and the weeding out of all unthrifty specimens. Hyperimmune *serum* is available for use in case of outbreaks, but does not appear to be very beneficial unless used in large doses early in the outbreak. Serum is better used to provide a passive immunity lasting for a period of from two to six weeks.

Swine Fever Vaccination.—A vaccine made from diluted, defibrinated blood containing swine fever virus inactivated with a solution of crystal-violet in ethylene glycol and known as the *Crystal-Violet Vaccine* is now extensively used to protect

FIG 43.—SWINE FEVER, SKIN LESIONS.

pigs against this disease. Pig's blood is generally used, but lapinized vaccine has been tested with promising results. Crystal-violet vaccine protects the animal against the natural disease for at least 12 months, and may be used on pigs of all ages. The great advances being made in tissue culturing of viruses may provide an even more satisfactory answer to vaccine production. If serum has been used on a herd, then the crystal-violet vaccine should not be used until the eighth to the tenth day after the injection of the serum.

The vaccine does not cure, and should not be used on ailing pigs. Being a preventive, if used on infected pigs it

may increase the severity of the disease and cause death. Care should thus be taken that vaccination is only performed on healthy pigs, and as the immunity takes about fourteen days to develop, the vaccinated animals should not be exposed to infection for the first fortnight after dosing. Apart from this period of isolation, the vaccine does not cause any disturbance to the healthy pig. Young pigs from non-vaccinated sows may be vaccinated before weaning, but where the mother has been vaccinated with crystal-violet vaccine, the young pigs should be kept for fourteen days after weaning before being injected.

The sites normally used for injection are the base of the ear, or the inner aspect of the thigh, and the dose for pigs up to 70 lb. live weight is 5 ml., with double the dose for pigs over that weight. It should not be injected too deeply into the fat, as the dye can remain there and be seen in the cured bacon.

This vaccine has many advantages over the older *simultaneous method*, where a combination of serum-virus was used, in that there is no danger in its proper use, and only one dose is sufficient for a twelve-months' immunity, enough to tide the pigs over to slaughter age.

B.T. Vaccine (Boynton's tissue vaccine) is made from finely ground virus tissue, and it is claimed for this vaccine that it is both adequate and safe. These tissue vaccines are made from spleen, lymph glands, kidneys, testicles, spinal cord and red marrow with blood suspended in glycerine 1 in 4 to which 1 per cent. eucalyptol is added.

Hygienic precautions must be applied in every outbreak of swine fever. Ailing pigs should be isolated at once. Pens should be cleaned out and thoroughly disinfected. Movement should be restricted as far as possible, whilst attendants should disinfect their boots before entering and on leaving infected premises. Above all, the sera or vaccines used must be in the hands of qualified veterinary surgeons only. It should be illegal for such articles to get into the hands of any pig man, however intelligent and able he may be.

In Great Britain swine fever must be reported to the police. as is the case with anthrax and the other scheduled diseases.

The Ministry of Agriculture and Fisheries are notified by the police and they send one of their veterinary surgeons to investi-

gate and report. The veterinary surgeon diagnoses the disease, but his diagnosis is subject to confirmation by the veterinary officers at the laboratory of the Ministry, to whom the field officer forwards material from a dead animal. The material forwarded should be sufficient to confirm the field officer's diagnosis, and it may be necessary to slaughter some of the ailing pigs to obtain confirmation of the suspected existence of the disease. Dead carcases must be cremated or buried in a covering of quicklime.

Restriction on animal movement into or out of the infected place is put in force by the local authority, and may remain in force for about three weeks or more, and the in-contact animals may either be sent under a special licence to an abattoir for immediate slaughter, or the owner may decide to call in his veterinary surgeon to carry out protective inoculation with hyperimmune serum.

Breeding stock should be separated from the diseased pigs. It is advisable to destroy all ailing pigs, and a separate attendant should be provided for them. Utensils, pens, etc., should be thoroughly disinfected with an approved disinfectant. (The local authority in each district has a list of such approved disinfectants.)

Where the owner of the herd decides to adopt serum treatment the cost falls on the owner, as it must be administered by his own veterinary surgeon. The advantage of adopting such treatment is that it enables pigs to be protected by an immunity which allows them time to be finished for slaughter or to be moved to a non-infected part of the premises. If pigs inoculated with serum are mixed with pigs suffering from swine fever they will probably get a mild form of the disease, and if that is done before the effects of the serum immunity are worn off the pigs will then remain permanently immune from swine fever. Owners who wish for a permanent immunity are therefore advised not to slaughter off all their affected pigs, so as to have some available for mixing with the serum-inoculated stock. It should be remembered that there is always a danger of an individual pig being already infected with the disease before the serum was administered. In that case the serum should not be blamed for failing to protect such a pig from a fatal attack of swine fever.

The immediate reporting of suspected cases to the police stressed, so that losses may be cut down to a minimum, l better results obtained from the serum treatment.

The reporting to the police does not in any way relieve the ner of his responsibility for the care and maintenance of pigs, or for the prevention as far as is practicable of unessary suffering from illness or other cause. The owner is liberty at any time, before or after the confirmation of the stence of the disease, to have his pigs treated on the infected ce by his own veterinary surgeon, provided the latter ains the necessary permit from an inspector of the local hority (generally a police officer) to enter the infected place, l disinfects himself on leaving in accordance with the rules forth on the Notice of Restriction served on the owner.

Rabies (hydrophobia, dog madness, lyssa).—This disease efly affects dogs, but is capable of being passed to pigs ough the bite of an infected dog. It is thus through the line species that the disease is spread. The disease is lely distributed throughout Europe, Asia, Africa and ierica, and was once known in this country, too; but thanks a very strict quarantine on all imported dogs, Britain is in fortunate position of being free from rabies.

The cause of the disease is a filtrable virus which is inoculated means of the teeth of an infected dog. In experimental imals, where the virus is injected directly into the brain, ith may take place within a week, but in the case of inocuion by the bite of a rabid animal, symptoms do not usually pear until about three weeks later, and they may even be layed for six months or, according to some authorities, a iole year. Not all animals so inoculated become rabid; proportion is believed to be about one in four or five, pending upon the virulence and amount of the virus present d the part of the body into which it was inoculated. In the man being bites upon the face and hands are likely to result rabies sooner than bites elsewhere, owing to lack of protion by clothing, and to the rich nerve supplies of these rts of the body.

Galloway and Elford, using a Pasteur Institute strain aris) of fixed virus, found that the particle diameter of the rus in their evaluation was from 100 to 150 mg.

The rabies virus travels up the nerve trunks to the brain and spinal cord, and is also disseminated through the nerve tissues of the body. The peculiar bodies found by Negri in the central nervous system of rabid animals were believed to be stages in the development of the infectious agent, and in cultures by Noguchi small oval granular bodies were observed just visible by high magnification. Inoculation of such cultures produced rabies in experimental animals and dogs.

Symptoms.—In the pig affected with rabies there may be some history of a dog bite. The animal goes off its food, is dull and quiet, and this stage later merges into one in which the appetite is abnormal, the pig becomes aggressive and greatly excited, ready to bite and fight. This is again followed by a stage of paralysis and weakness of the hind-quarters, with a general paralysis which may prove fatal in from one to four days' time.

A post-mortem examination might reveal some abnormal material in the stomach, with evidence of some emaciation, but for a positive diagnosis resort has to be made to the microscopic examination of the hippocampus and tbe discovery of Negri bodies, and there are also histological changes in the sympathetic ganglion of the vagus nerve.

Treatment is strictly prohibited in this country, but the disease is hardly likely to be encountered in British pigs nowadays. The Ministry of Agriculture and Fisberies deal with this condition, as they do with all the scheduled diseases.

Pasteur's treatment is used in many countries for the cure of rabies. This consists of a series of injections of virus of varying virulence. Other types of protective inoculations are also used, such as the use of a glycerocarbolized vaccine, which is harmless and effective.

Atrophic Rhinitis of Pigs (rhinitis chronica atrophicans).—This disease occurs in young pigs under six months of age, and although suckers and weaners are the ones most frequently affected, it is not unknown in sows and boars. The disease attacks herds in the United States of America, Germany, Denmark and the Scandinavian countries. Until recent months it was not known in Britain, but following the importation of some Continental pigs into England and Scotland towards the end of 1953 and the early months of 1954, cases of

atrophic rhinitis have been found in the progeny of such imported stock, so that the British Government has now brought the disease under its control through the "Atrophic Rhinitis Order" of 1954. This has the effect of including the condition as a notifiable disease along with Swine Fever and the other diseases scheduled under the Diseases of Animals Acts and Orders.

In certain American states the name bull-nose of pigs is given to this form of rhinitis, but it can occur without any of the granulomatous swellings found in bull-nose, and it spreads to newly purchased pigs, indicating some contagion. A rhinitis does occur in many pigs following an acute sinus infection or secondary to virus pneumonia, but that does not lead to distortion of the nares as in atrophic rhinitis, although it may show some deformity of the turbinate bones. An ordinary rhinitis is not contagious, but atrophic rhinitis is, and it may occur without any lung lesions, as well as in conjunction with pneumonia and empyema. Transmission is by direct contact.

The exact cause is not known, but various factors have been suggested, such as a congenital predisposition in animals having a relatively short snout. Short-snouted breeds are common in Britain, but this disease has only been encountered there in the progeny of long-snouted European pig breeds. Short-snouted breeds naturally have atrophied nasal bones, but they are not known to have harboured this disease in Britain. It has also been regarded as a chronic form of pyocyaneus rhinitis as being due to infection with *B. pyogenes*, with spirochætes, or a virus. The possibility of an affinity with vitamin or mineral deficiency does not seem to have been thoroughly investigated as yet. Experiments on piglets up to 4 days old have shown that crude lung and turbinate suspensions treated with penicillin and thallous acetate can reproduce turbinate atrophy, whilst oxytetracycline appears to inhibit the agent. *Pasteurella multocida* and *Alcaligenes* species have been recovered from some atrophic turbinates, and found capable of reproducing the disease. Prolonged irritation of the nasal cavity by non-infectious material will also produce turbinate atrophy, but not the pneumonia. From all this it has been suggested in the United States, that atrophic rhinitis is not a specific disease.

Symptoms.—Affected animals are unthrifty and stunted in growth, with snuffles owing to an accumulation of purulent or bloody exudate in the nasal cavities. The twisted snout is better seen viewed from the front, rather than from the side. Young piglets from 2 to 6 weeks old can be infected, get to the acute stage, and proceed to a more chronic and milder state later. The lacrimal duct is often choked resulting in a tear-and-dirt stained patch below the eye. There is frequent sneezing, especially if the pigs are disturbed purposely, when

Fig. 44.—Atrophic Rhinitis. Cross section of the Nose of a Landrace Pig.

the increased respiratory movements bring out the snoring or snuffling. Appetite is in abeyance, and the pigs rub their snouts against the pen walls as though trying to get rid of some irritant. There may be some nasal bleeding, conjunctivitis, and symptoms of pneumonia. Later on there is a nasal distortion, with a swelling or enlargement of the facial bones.

Post mortem.—If the head is sawn transversely over the snout about three or four inches from the tip of the nose, the septum nasi as well as the turbinate bones can be examined. The septum may be twisted to one side or even necrotic, whilst

the turbinate bones are deformed so as not to fill the nasal cavity, whilst the nasal mucosa is inflamed and may even be purulent. The degree of degeneration in the nasal turbinate bones varies from a slight shrinkage to complete disappearance. The facial bones are swollen, with some sinus infection, whilst the lungs may show lesions of pneumonia, of multiple abscesses, or of empyema. The carcase is emaciated in advanced cases. Done reports large granular basophil inclusions, and smaller acidophil inclusions in the nuclei of the nasal mucosa glands.

Treatment.—No effective treatment is known, although the administration of iodides, nasal douches, etc., have all been tried. The building up of a strong resistance in the young animal through the medium of the its own dam would appear to be the rational treatment to suggest, as a preventive measure. Heavy sulpha drug dosage into the blood stream is likely to give better results than antibiotic treatment, as far as the curing of lesions due to secondary invaders is concerned in weaners. In Britain the *Atrophic Rhinitis Order* of 1954 lays down the procedure to be adopted.

Under this Order the disease is notifiable, and a veterinary inspector serves notice upon the herd owner to have the suspected pigs isolated, pending inspection and slaughter. For this compensation is payable to the extent of one-half the value of the affected pig immediately prior to slaughter, and full value for the in-contacts. The premises where the animals have been are thoroughly cleansed and disinfected, as are any utensils used for the infected pigs. The local authority is responsible for seeing that this Order is carried out.

Differential diagnosis.—Ordinary rhinitis does not result in the distortion of the nasal bones found in this condition, nor is there usually any nasal bleeding. In acute pneumonia or pleurisy, in addition to the absence of distortion of the nose, it is not usual for a whole litter to be affected all at once. Resort to slaughter and examination of the nasal bones and membranes may have to be resorted to in order to distinguish between rhinitis and paratyphoid or necrotic enteritis and swine fever nasal gleet.

A condition first described in Britain in 1955 by Done, and called Inclusion Body Rhinitis (IBR), is clinically related to atrophic rhinitis. Done reported that typical lesions could be

demonstrated in the early stages of atrophic rhinitis, and that atrophic changes could be produced in susceptible young pigs by the intranasal instillation of material from pigs affected with IBR. (Harding (1958)) suggests that the causative agent of IBR is a member of a group of agents causing cytomegalia in man and a number of other animals, and may be a factor in the production of atrophic rhinitis.

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Chapter 7

DISEASES (GENERAL)

Tuberculosis.—This disease affects both man and animals, and is known by a variety of names such as consumption, phthisis, scrofula, pearl disease, lupus, grapes and tabes mesenterica. The organism responsible is the *Mycobacterium tuberculosis* or Koch's bacillus. There are several varieties of the bacterium, and practically all common animals and man are susceptible to it, including wild animals when in captivity. The normal progress of this disease is slow and it is characterized by the formation of nodules or " tubercles " of varying sizes in different parts of the body. This slow progress of the disease often masks its symptoms in the pig, and most cases are not found out until the animal is slaughtered and the disease detected by a meat inspector.

Whilst the associated organism is *M. tuberculosis*, the predisposing cause appears to be domestication, with its attendant restriction upon movement, access to sunlight, fresh air, green food, etc. The disease may thus be classed as one of civilization, but although it is a very old disease, evidence of its ravages being said to have been found in ancient Egypt, it is not hereditary in that the bacterium is not passed through the ovum, but it may be congenital. The young animal may be born with the disease derived from an infection *in utero*.

The three most common types of the *M. tuberculosis* are the " human," " bovine," and " avian " types. The bacterium is a slender rod-shaped organism with rounded ends, and showing granular forms under certain conditions. Its length is from 2 to 5 μ, and its width from 0·3 to 0·5 μ. It is usually in the form of straight rods, but it may be bent, appearing singly or in groups, or branched. It is non-motile, and is believed to be a non-spore producer (although certain beaded forms are sometimes seen), growing on glycerin agar, blood serum, egg slant or bouillon. It is aerobic, with temperature limits for growth of from 29° to 42° C., and with

the exception of young and rapidly growing forms it is acid-fast, and is usually demonstrated in cover-glass smears with the Ziehl-Neelsen method (or some of its modifications) used for staining acid-fast organisms. The organism is destroyed by heat at 85° C. for five minutes, or boiling point for one minute. A dihydric alcohol called phthicerol has been isolated from the wax fraction of both the human and bovine types of *M. tuberculosis*.

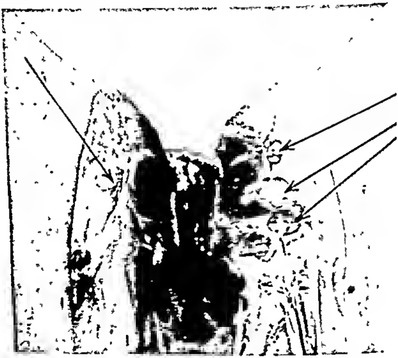


FIG. 45.—HIND-QUARTERS OF A PORK PIG, SHOWING TUBERCULOUS LESIONS IN THE SPERMATIC CORD.

Tubercle bacteria do not multiply in nature outside the animal body, and so dissemination depends upon infected animals and material from infected animals. The microscopic appearance of the three types of *M. tuberculosis* is very similar, and it is only by typing through experimental animals that the types can be distinguished with certainty. Infection in pigs is believed to be about two-thirds from the bovine type, with the avian type responsible for almost all the remaining one-third, with perhaps a trace of infection due to

the human type bacilli. Cornell and Griffith found from experiments with diseased glands from pigs that natural infection in that animal might be from bovine, avian or human strains of the bacillus, but that the chief cause was the bovine tubercle bacillus. They found that the avian bacillus is responsible for a considerable proportion of the cases in which the lesions are apparently confined to the lymphatic glands of the alimentary tract. Cotchin, reporting on the isolation of tubercle bacilli from the submaxillary lymph nodes of eighty-six pigs, was able to isolate strains of the organism from sixty-eight cases. Of these strains twelve were of the avian type, and a further ten described as probably of avian type, while forty-six were of the mammalian or bovine strain. The writer has found that in the course of the inspection of millions of pig carcases of all ages from various parts of the British Isles, 11 per cent. showed some lesions of tuberculosis. Since the eradication of the disease in dairy cattle in Britain, the disease in pigs has dropped to about 3 per cent. The percentage of porcine tuberculosis in the United States is also said to be 11 per cent. In some meat export works in New Zealand up to 20 per cent. of the pigs have been found to be tuberculous, according to Hankin, most of the lesions appearing in the submaxillary lymph glands. By far the highest incidence of tuberculous lesions is found along the alimentary tract glands, the submaxillary glands of the throat and the mesenteric glands of the intestines, pointing to an infection by ingestion rather than inhalation. Other possible routes of infection, apart from ingestion, are inhalation, inoculation—*e.g.* via wounds such as the castration wound—congenitally, and by way of the urogenital tract from boar to sow during service. All these latter methods are extremely rare in pigs, although a tuberculous infection in the spermatic cord in a castrated pig is occasionally found, with no evidence of the disease elsewhere in the body.

The common method of infection in the pig is from the food supply, where milk or milk products from tuberculous cows are fed unboiled to pigs, or where food and pastures are contaminated by the excreta of tuberculous animals, notably diseased poultry. Most of the tuberculous pigs in Britain were found in the districts where dairy products were normally fed

to pigs, and where there was a high percentage of tuberculous cows.

In the United States avian infection plays a greater part in porcine tuberculosis, as the incidence of tuberculosis in

FIG 46.—LUNG TUBERCULOSIS IN THE PIG, SHOWING ENLARGED BRONCHIAL LYMPHATIC GLAND AND A TUBERCULOUS PNEUMONIA OF THE ANTERIOR LOBE OF THE LUNG

bovines is low in that country owing to the eradication methods in force.

The disease may affect pigs of all ages, although there is a greater tendency to generalization in the young. The more acute type of tuberculosis is often encountered in the pig up to bacon weight, whereas old sows and boars tend to show a type of the disease in which calcified lesions are more common.

Symptoms.—At first pigs affected with tuberculosis appear to thrive and put on fat. The appetite is good, later becoming capricious. Further symptoms depend upon the site of the lesions in the body; usually these are in the throat glands and the mesenteric lymph glands. In cases where the throat lymph glands are badly infected and swollen there may be a distinct swelling of the jowls, visible during life. If the animal is made to walk and exert itself a harsh blowing noise can be heard, as though there were some throat obstruction to respiration. There may be a husky cough. In tabes mesenterica emaciation sets in with diarrhœa, alternating with periods of normal fæcal passage. The abdomen may be tucked up, and in the later stages of the disease anæmia is a pronounced symptom.

The slow development of symptoms in this disease and the localized condition often found on post-mortem examination make the diagnosis difficult in many cases without the aid of the tuberculin test, whilst the finding of acid-fast bacilli in the sputum and discharges will necessitate a resort to biological methods in order to demonstrate with any degree of certainty that one is dealing with tubercle bacilli and not some other acid-fast organisms.

The tuberculin test may have to be resorted to in the case of valuable breeding animals. The subcutaneous test, which was once widely used in cattle, was superseded by the double intradermal test, the latter being now replaced by a single intradermal test. An area of skin at the base of and behind an ear is shaved and cleansed, after which a dose of concentrated tuberculin, usually mammalian, is injected into the dermis. Skin measurements are taken prior to the injection of the first dose, and at the seventy-second hour. A diffused swelling, somewhat œdematous, and in many cases painful, indicates a positive reaction. In a non-reactor there should be no swelling beyond that due to the actual injection itself. The size of the swelling in a reacting pig bears no relation to the extent of the lesions found in the body, as the test serves to indicate the presence or absence of a tuberculous infection rather than the extent of such infection.

A reacting pig shows first a small firm nodule at the site of the injection, and this soon increases in size, becoming

œdematous and purple. The reaction increases in size until the seventy-second hour. Sometimes ulceration takes place, but the reaction has usually subsided in about a week. Throughout this period the pigs show little or no disturbance in their feeding and general health. It is generally recommended that the tuberculin used for pig testing be mammalian, using 0·1 ml. at a strength of 1·5 mg. per ml., and that the site of injection be the skin at the anterior border of the ear, about one-third up from the base, but the site will naturally depend upon the breed of the animal—*i.e.* the shape of the head and ears—and the convenience of the surgeon carrying out the test.

In the cutaneous test a prepared area of skin is scarified and then painted over with concentrated tuberculin. In a positive case the skin becomes œdematous and swollen in from twenty to thirty hours, and this persists for some days.

The ophthalmic or conjunctival test is difficult of application in the pig. In this test a few drops of specially prepared concentrated tuberculin are dropped into the conjunctival sac, and the head held firmly until the tuberculin is distributed under the eyelids. The eye is examined at the eighth or ninth hour afterwards, and compared with the normal eye. The positive reaction consists in some conjunctivitis with some purulent discharge in the inner canthus, and this may persist for a few days.

Post mortem.—Nearly all cases of tuberculosis in pigs are only discovered at a post-mortem examination in an abattoir in the course of meat inspection. The commonest form of lesion consists of a tiny spot or spots of yellow pus in one of the lymph glands. The submaxillary glands are often affected in this way, but it must be remembered that secondary pus-forming organisms may invade a tuberculous gland and cause many of these lesions Hankin submitted some fifty such pig glands to a microscopic test and found only three positive; a further twenty-six were submitted to a biological test by guinea pig inoculation and eleven were positive and fifteen negative. Cotchin, to whose work reference has already been made, also found he was able to isolate strains of tubercle bacilli from only sixty-eight out of the eighty-six cases in the submaxillary lymph glands of the pigs. *Corynebacterium equi* was isolated from eight of such cases showing lesions resembling those of

tuberculosis in the glands concerned. These findings are of importance, as they show that not all the naked-eye diagnosis of tuberculosis in pigs' heads after slaughter is true. In searching

FIG. 47.—TUBERCULOSIS IN THE PIG, SHOWING LESIONS ON THE PLEURA COVERING THE RIBS.

A portion of the right lung is adherent to the chest wall and contains calcified masses. The bodies of the last cervical and first thoracic vertebræ also show lesions of the disease, whilst further centres are found about the ninth thoracic vertebral body and in the spinal canal. This bacon pig, although comparatively "lean," shows no lack of peritoneal fat.

for acid-fast organisms in such lesions it is often impossible to find any, although some may be found in the apparently healthy gland substance. Similar lesions may be found in any or all the lymph glands of the body, depending on the extent

of the infection. Later, the glands become swollen, congested around the periphery, and show distinct evidence of the presence of caseous matter. At a later stage this caseation may give way to calcification following the deposition of lime salts in the glands and lesions. In miliary tuberculosis small miliary tubercles are found throughout the lungs and liver. The disease may spread to all the organs throughout the body, and is sometimes found in the bones, notably those of the vertebræ. The bone becomes softened and cavities are formed filled with a caseous yellow matter. For this reason it is advisable in meat inspection to have all pigs in which tuberculous lesions are found split down the backbone, so that the vertebræ can be examined. The disease spreads via the lymph stream, but when generalization sets in the bacilli may be carried by the blood to any part of the body.

Tuberculosis of the bronchial glands is often accompanied by tuberculosis of the hepatic glands, and although most of the larger lymph glands in the body may show distinct lesions, the smaller glands, such as the subdorsal and sublumbar glands, will often show no evidence of tubercles, but just a slight swelling and congestion of the gland substance. It is sometimes possible to find that the lymph glands on one side of the body are badly tuberculous, with no macroscopic evidence of the disease in the corresponding lymph glands on the other side of the body. Also, tuberculosis of the vertebral column is sometimes encountered, with no lesions visible in any lymph glands, and a tuberculous mastitis is often seen in sows.

In the United States of America, of 45½ million pigs killed under Government supervision, 11 per cent. were affected with tuberculosis. Experiments carried out in America show that where the disease was localized, as found in slaughtered carcases, a histological and biological test of apparently healthy lymph glands in a small percentage of cases showed that virulent bacilli could be recovered from such glands.

For the discovery of acid-fast organisms in suspected cases the well-known Ziehl-Neelsen method of staining is resorted to.

Treatment.—Curative treatment is useless, and where the disease is suspected, attention should be paid to the possible sources of infection—milk or milk products, tuberculous

poultry, an infected breeding sow or boar, etc.; steps should be taken to prevent any further contamination. Where pigs are found at slaughter to be tuberculous, an attempt should also be made to ascertain the breeding sow, and she should be slaughtered off if tuberculous. Housing, sanitation, and feeding all play their part in this disease, and the general conditions under which the pigs are kept should receive attention. If a herd of cows is kept on the same farm, they must be tested with tuberculin by a veterinary surgeon. All reactors and tuberculous animals must be slaughtered. Poultry should not be allowed to contaminate pig pastures, feeding troughs, and sties.

B.C.G. Vaccine.—A considerable amount of research work with B.C.G. vaccine in calves has been carried out in this country. It has been shown that calves which receive the vaccine intravenously resist infection by artificial or natural exposure at a subsequent date. The duration of the resistance has not yet been fully established, but it is known that, in order to obtain satisfactory results, it is necessary to reinforce the resistance by further injections from time to time. The present procedure is to inject the vaccine at six-monthly intervals. The vaccine is now in general use in many countries for combating the disease in human beings.

Aujesky's Disease (infectious bulbar paralysis, enzoötic meningo-encephalomyelitis, pseudo-rabies, mad itch).—This disease is caused by a filter-passing neurotropic virus. It is possible that there are strains of this virus affecting a variety of animals and causing some slight variation in the symptoms exhibited. The rat has been blamed for transmitting the disease, and so has infected garbage and kitchen waste. Cats have been known to develop the disease after fighting rats. Whilst suspension of brain material from infected piglets has failed to set up the disease when injected into others, intracerebral injections of brain material from experimentally infected rabbits have been known to cause the disease to appear in pigs.

Inflammatory lesions of the central nervous system are prominent in the disease, which causes a transient illness, with depression, inappetence, rise in temperature, and a degree of contagion. Tests for neutralizing antibodies against the

virus were made in America, by inoculating guinea pigs with mixtures of serum and virus. Neutralizing antibodies were found to be present in most of the blood samples used. Similar tests carried out in England proved negative. Using a Hungarian and an American strain of the virus, Galloway and Elford found no essential difference between the two. They reported the virus to have a particle size of 100 to 150 mμ.

Symptoms.—The incubation period in naturally occurring cases is from one to four weeks. The young pigs appear dull, give up suckling, and walk aimlessly around the pen. Accompanying this lassitude is a rise in the temperature of the infected animal to 104° or 106°. Muscular tremors appear all over the body. The pig lies down, rolling its eyes. The nose is extended backwards and upwards, eyes closed, and legs extended stiffly, with a hollowing of the back. The epileptic spasms disappear leaving the animal exhausted, but any excitement or attempt to get up even will bring on another spasm. The pig affected may appear to be blind, rubbing its nose against the pen wall, or rubbing the mouth with the forelimbs, until the part becomes sore and bleeding. Some frothing at the mouth, champing of the jaws, and vomiting is sometimes seen. In other cases the pig sits like a dog, or crawls on its belly. The voice gets progressively weaker, and may be lost entirely, as the animal becomes more helpless. Sensitiveness in the skin is decreased in parts, and is occasionally lost entirely. The patellar reflex is absent. Some cases show good appetite, and in such cases the prospects of recovery are usually good too. The period of convalescence is, however, long, from one to three months. Conjunctivitis and constipation are other symptoms of the disease. In bad cases the disease terminates fatally in from eight to twenty-four hours.

Diagnosis.—This disease may be distinguished from rabies by the absence of any aggressive symptoms in the animal affected. Convulsive symptoms are a feature of Aujesky's disease, and a rapid spread amongst animals in a herd, with many recoveries, differentiates it from swine fever. Teschen disease, which is so similar to Aujesky's disease as to cause it to be regarded by some people as merely a variant of the latter condition, is said to be differentiated by inoculation of

material from infected rabbits only. Such inoculation does not produce Teschen disease in pigs.

Post mortem.—The only changes apparent are a hyperæmia of the brain. Suspensions of brain substance from pigs dead of the disease, if inoculated into rabbits, may cause death in the experimental animals in about three days' time. Histological examinations of the central nervous system may show a lymphocytic non-purulent encephalomyelitis extending to both the grey and white substance. There is an overgrowth of the glia cells, especially in the dorsal grey horns of the spinal cord. There may also be a cellular infiltration of the meninges and a severe derangement of the nerve cells. No inclusion bodies may be visible. These tissue changes are said to develop within a few days or a week after the onset of symptoms. In young pigs they may develop within a day after the first symptoms are shown.

Treatment.—No effective curative treatment is at present available, and preventive measures should consist in the destruction of rats on the premises and the avoidance of contact between rats and young pigs. The proper feeding of pigs and the provision of healthy surroundings may do much to prevent this and many other conditions in pigs. Hyperimmune serum has been found to be ineffective in protecting the live pigs, although it may neutralise the virus experimentally.

Teschen Disease.—This disease is an encephalomyelitis of pigs which has been described as occurring in Czechoslovakia, Germany and Switzerland. It has many features in common with Aujesky's disease, and may well be a variant of that disease (see Talfan disease). Teschen disease is caused by a filter-passing neurotropic virus. Riedmüller claims to be able to differentiate this disease from Aujesky's disease by the fact that whereas material from experimentally infected rabbits may set up the latter disease in pigs, that is not the case in Teschen's disease. Morzan claims that his condition can be diagnosed histologically, and that the lesions do not occur in any other pig diseases. Teschen disease results in certain characteristic changes in the central nervous system, such as a perivascular lymphocytic infiltration and a degeneration of the ganglion cells in the ventral horns, especially in the posterior part of the cord. In swine fever and paratyphoid, the lesions are

evenly distributed throughout the white and grey matter. In spite of that, the disease would appear to have more in common with Aujesky's disease than any other.

Rats are not regarded as being responsible for the spread of the infection. Kitchen waste and garbage are blamed for the spread, as also is direct infection through contact with discharging skin lesion, saliva, urine or mucus, blood and offal from home-killed pigs.

Symptoms.—In slowly developing cases the gait becomes somewhat stiffened, with a tendency to trip, due to the muscular rigidity. Temperature may rise to 106°, whilst the animal may be completely helpless, lying on its side, or squatting like a dog, as in the previously described disease. Spasms of the limb muscles occur, with grioding of the teeth and smacking of the lips. The animal is in acute pain. Skin sensitivity is decreased or lost. The appetite may remain good, and in such cases the chances of recovery are also good, although the period of convalescence may be a long one.

Treatment.—There is some evidence that this disease occurs on farms where overstocking and faulty feeding are prevalent. Vaccine treatment is still in the experimental stage, but attention to hygiene and dietetics should prove of value in checking the spread of the disease. The slaughter policy, with disinfection and isolation of premises, has been successful in preventing its spread.

Actinomycosis.—This disease is most often found in cattle, where it is known as "lumpy jaw." In pigs the disease usually attacks the udders in sows, and is very rarely found in pork and bacon pigs.

The organisms responsible for this condition are members of the Actinomycetaceæ family (*Actinomyces bovis* and *israeli* and *Streptomyces* species), believed to be normal inhabitants of the alimentary canal of pigs. The organisms grow in the tissues as small colonies from microscopic dimensions to those about the size of a pin's head. A young colony is usually composed only of filaments, but in older colonies the club formation may be seen at the periphery. The ends of some filaments may break up, giving the appearance of cocci. The clubs are acid-fast provided a 3 per cent. solution of sulphuric acid is used for decolorizing with the Ziehl-Neelsen stain, a saturated solution of picric

acid being used to remove excess of colour and give a yellow background. The filaments are Gram positive, but the clubs are usually Gram negative.

The actinomycotic pus is often of a greenish-yellow colour, and may show yellow irregular particles throughout, these being the colonies of actinomyces.

Symptoms.—A lumpy swelling in the region of the sow's udder is usually noticeable. The swelling may take the form of multiple small abscesses distributed throughout some of the mammary glands, or it may occur as a large pendulous swelling on one gland, often with some open discharging sores where there has been some secondary infection with pyogenic organisms. In extreme cases the swelling may be so large as to cause the gland to touch the ground when the sow is standing. It occurs in sows that have had numerous litters. When the disease affects some of the internal organs, symptoms are not usually recognized during life, and they largely depend upon the organs affected. If in the stomach, the disease may set up indigestion and a general emaciation which is not at all specific.

Post mortem.—A purulent form of mastitis may be encountered, often with dense, tumour-like formation. In other cases small abscesses may be found along the region of the mammary glands; these abscesses are about the size of a hazel-nut, and may extend along the whole length of the mammary glands in sows. On rare occasions similar lesions due to the actinomyces may be found internally on the abdominal wall, in the internal organs and tonsils. Lesions may occasionally be found in the spermatic cords of castrated pigs.

Treatment.—Iodine was once thought to be a specific for this disease, but it is now known that many of the conditions for which the iodine treatment was applied were caused by the actinobacillus rather than the *Actinomyces group*. Drugs of the sulphanilamide group are worth trying in this condition, as the infection is often complicated by the presence of cocci in the lesions. Treatment with sulphapyridine and colloidal iodine may sometimes give good results if it is considered worth adopting, when the age and economic value of the patient are taken into account. Sulphadimidine and streptomycin exert an excellent synergistic effect.

Actinobacillosis (also known as "Wooden Tongue") is a disease primarily of cattle caused by the *Actinobacillus lignièresi*, which was at one time confused with the disease actinomycosis. The actinobacillus is a small non-motile organism, and both the organism and its clubs are Gram negative. The actinobacillus tends to invade soft tissues, and may be found causing lesions in the lymphatic glands. It is not known for certain what percentage of the actinomycotic conditions found in pigs are due to this organism, but it is possible that many of the spermatic-cord and lymph-gland abscesses containing a greenish-yellow pus, and often surrounded by a thick fibrous capsule, may be due to the actinobacillus.

Symptoms.—These are similar to those found in the condition known as actinomycosis. The internal lesions, being usually quite local in origin, are not discovered until after death.

Iodine in the form of potassium iodide has been long recognized as giving good results in the treatment of actinobacillosis, and a treatment with potassium iodide, colloidal iodine, or sulphonamides may be worth trying in the ease of a valuable patient, but it is hardly likely that any breeder would wish to breed from a sow affeeted with abscess formations in the mammary region, and as it is usually old sows that are affected with these actinomycotie eonditions, it is often best to fatten them up for slaughter rather than attempt treatment. Sodium iodide in a solution of 1 oz. to a pint of distilled water has been used successfully for the treatment of actinobacillosis in cattle in America by intravenous injection. It is possible that a correspondingly smaller dose may be of benefit in cases of the disease in sows.

The organisms *Botryomyces ascoformans* and the *Staphylococcus pyogenes* have also been incriminated in these mastitic conditions in sows, and in abscess in the spermatic cords of castrated pigs. Some research workers regard these two organisms as one and the same. Infection usually occurs by inoculation, such as in castration wounds, and microscopic examination of the pus may be necessary to distinguish them from actinomycosis.

Treatment is similar to that prescribed for actinomycosis. Abscesses should be opened and wounds cleansed thoroughly.

Variola Porcina, or Swine Pox. A disease known as

swine pox, or variola suilla, has long been known and regarded as one of the series of diseases known as the variolæ, characterized by an eruptive fever with the development of skin eruptions, and being of a very contagious nature. The origin of the disease is obscure, and it is possible that in the pig skin eruptions due to swine erysipelas and dietetic errors may have been confused with true variola. The disease in pigs has been said to emanate from a human source of infection, and it can be passed on to other animals.

The variola series of diseases in different animals have been regarded as being due to filtrable viruses, and certain cellular elements suggestive of a protozoan nature in the lymph have been discovered. Later work on the disease suggests that the virus passes various types of filters, and that it is aerobic. Certain bodies have been found in the clear spaces in the cytoplasm of skin lesions, and of these the Paschen granules found in stained smears of lymph, and resembling cocci, are believed by some to be the vaccine virus. Very little work seems to have been done on the virus of swine pox, and whilst the disease in pigs has been reported from Europe and Africa, so far little evidence has been collected as to the infection as it affects British pigs. The disease is said to affect chiefly young pigs, and to occur in a mild form, or as an epidemic. There is occasionally seen in British pigs of the pork and bacon type a skin disease in which, at post-mortem examination, small circular scabs are found along the belly and flanks. These scabs are usually circular and about ½ inch in diameter. When the scab is removed, a small depression is left in the skin. The origin of this condition is obscure, and the condition is usually mild, the scabs being comparatively few in number, and the internal organs and lymph glands show no evidence of any systemic disturbance. These scabs are much smaller than those usually associated with swine erysipelas, and show a circular outline rather than the diamond shaped outline one expects to find in erysipelas skin markings.

Symptoms.—These are said to follow the usual variola stages. First there is a febrile stage, with loss of appetite. The period of incubation is about five days, and is followed by the *papular* stage, when small red swollen areas appear on the skin of the belly, thighs, and flanks, as well as on some

[*Veterinary Record*

FIG. 48.—PIG VARIOLA: ABOVE, SCAB FORMATION. BELOW, SKIN LESIONS.

other parts of the body. The lymph in the swelling becomes purulent at about the eighth day and forms the *pustular* stage. Necrosis of the surface and exudation of lymph follows, the lymph drying into a thick scab, and these fall off in about three weeks from the commencement of the eruption—the

FIG. 49.—VARIOLA TYPE LESIONS ON THE HINDQUARTERS OF A YOUNG PORK PIG.

desiccation stage. The disease is seldom fatal unless the respiratory tract is involved.

The disease varies in its severity from a benign condition occurring in pigs kept under insanitary conditions to a severe outbreak which may readily spread from infected to in-contact pigs, and be associated with a high mortality. Blakemore and Glover described a variola infection in pigs in East

Anglia. The pigs affected were between the ages of three and six weeks, but a few mild cases were also found in older store pigs. The little pigs showed inappetence and dullness, with the appearance of reddened areas on the skin up to about ½ inch in diameter on various parts of the body. The lesions were well defined and rarely coalescent. The short erythematous stage progressed to scab formation without vesicular production. Later the areas become well demarcated by a peripheral wall of raised fibrous tissue, which in some instances induced a crater-like appearance. The scabs could be removed without difficulty, and secondary infection was not commonly observed. The disease ran its course in about three weeks, and resulted in some loss of condition and unthriftiness. The affected animals were segregated and sows with litters were isolated until the little pigs were about six weeks old.

No definite changes were found on post-mortem examination in any of the internal organs, and histological examination of skin sections showed the lesions to be superficial and not extending beyond the Malpighian layer. A marked cellular infiltration was found between the epithelial cells, which exhibited a certain degree of vacuolation. There were no cell "inclusion bodies."

That the condition was infectious was demonstrated by the dermal inoculation of an experimental pig aged about ten weeks. The application of a suspension of superficial crusts obtained from a natural case resulted in the production of a very typical syndrome. At the third day an erythematous eruption was produced which lasted for forty-eight hours, followed by a stage of flat pustules with umbilicated centres without the appearance of definite vesicles. The lesions finally changed to superficial scabs. Very little systemic disturbance was produced. The pig was slaughtered ten days after inoculation, and a suspension of mixed liver, lung and spleen inoculated into a second pig produced a rise in temperature and some loss of appetite five days later, but there were no skin lesions, nor was there any infection passed to an in-contact pig. These last two pigs, together with a control pig, were later tested on the thigh with a suspension of fresh vaccine lymph from a rabbit, and they all showed typical vaccinal

eruptions. Inoculation of laboratory animals with material from the first pig proved negative.

Treatment.—An animal that has recovered from a natural attack of the disease is said to develop an immunity, and protective vaccination has been carried out with both the swine-pox and cow-pox virus. This disease has not been

FIG. 50.—VARIOLA TYPE LESIONS ON THE SKIN OF A BACON PIG.

reported to cause any great loss amongst British pigs, so that vaccination against the condition has not been carried out here. Should an outbreak occur, the affected animals are best slaughtered. In-contacts could be vaccinated with a cow-pox vaccine if a swine-pox vaccine is not available. Piglets inoculated with a glycerinated variola will show good local

lesions with no generalization. Saponin and fatty excipients have no localizing effect upon the virus after inoculation. Attention should be paid to the diet, which should include some laxatives. The possibility of mineral or vitamin de-

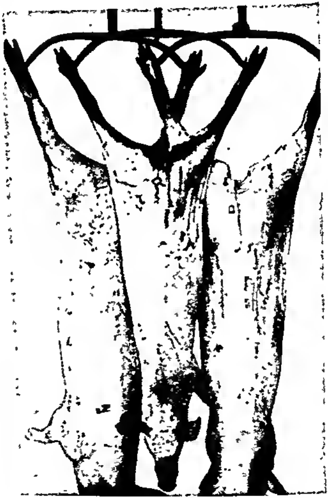


FIG. 51.—A VARIETY OF SKIN LESIONS IN PIG PARATYPHOID.

ficiency in the ration should be explored, infected litter burnt, and pens and premises disinfected.

Pig Paratyphoid (necrotic enteritis, infectious enteritis, or salmonellosis of pigs) is a disease affecting chiefly young pigs in the autumn and winter months, but in severe outbreaks the nursing sow may occasionally be infected as well, without

showing any of the characteristic type of ulceration in the bowel. The organism *Salmonella suipestifer* has been mentioned as the cause of this disease. It is a secondary invader in swine fever, and it was once thought to be the actual cause of swine fever until the discovery of a filtrable virus. The Salmonella organisms belong to the food-poisoning group, and in the pig, in addition to *S. suipestifer*, *S. aertrycke* and *S. enteritidis* are also encountered. The Salmonella organism is found in the intestinal contents of normal healthy pigs, and

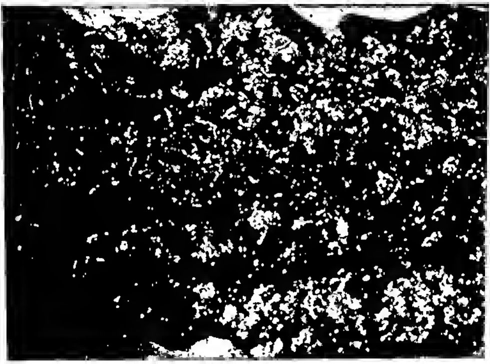


FIG. 52.—NECROTIC ENTERITIS—SECTION OF MUCOSA OF LARGE INTESTINE.

is believed to become virulent and to set up a diseased condition in the pig body when the animal's vitality has been lowered by some other factor. (See Avitaminosis.) The predisposing cause of the paratyphoid infection may therefore be due to some dietetic deficiency, bad housing, heavy worm infection, and introduction of fresh infected pigs to the herd, or anything having a tendency to lower the vitality of the young pig.

Salmonella organisms may be found in the intestines of normally healthy pigs, and when these organisms become patho-

genic it is usually due to a lowering of the normal resistance of the pig. Experiments carried out in Yugoslavia tend to show that a lack of vitamin D may play an important part in acting as a predisposing cause of paratyphoid. Pigs fed on a ration deficient in vitamin D and then fed Salmonella organisms developed paratyphoid, whereas pigs receiving the vitamin in their food did not contract the disease. Cases of paratyphoid which the writer has investigated have all been due to (*a*) vitamin and mineral deficiency causing general

FIG. 53.—NECROTIC ENTERITIS SECTION OF BOWL MUCOSA OF A CHRONIC CASE

unthriftiness and a lowering of vitality, or (*b*) to the introduction of infection into a herd from purchased pigs, and their general mixing together without any preliminary isolation. The diet in the latter case could not be completely exonerated. The fact that this disease may exist without the Salmonella organism points to its being primarily a nutritional disease, and that the organsim is secondary to the food and general conditions under which the pig is kept.

Salmonella organisms are said to have a tendency to localize in the intestines and genital organs in adult animals,

abortion being a common sequel to infection. In young pigs the disease is septicæmic in character.

The disease appears to have a seasonal incidence, the winter months being the peak months, according to Beckett, and bearing in mind that one of the predisposing causes of

FIG. 54.—PIG PARATYPHOID: ULCERATIONS IN THE CÆCUM.
The background shows tiny hæmorrhages in the skin of the carcase.

the disease may be some dietetic deficiency, such a seasonal incidence is understandable.

Beckett describes the disease as usually assuming a chronic course, in which the pigs are listless and begin to lose condition about the fifth week, with thumps diarrhœa, scurfy skin and anæmia.

Symptoms.—The symptoms in the live animal closely resemble those of swine fever. It is usually the young stock under six months old that are affected. The animals refuse food, and tend to lie huddled together in a corner of the sty; temperature rises, there is also a profuse diarrhœa of yellowish colour and with a very offensive odour, and in some cases there may be blood passed. Emaciation becomes noticeable, and the animals may linger on for a few weeks before death occurs. In very acute cases a reddisb discoloration of the skin of the ears and buttocks may be noticeable, whilst in other cases the discoloration takes the form of very fine pin-point hæmorrhages which may, and often do, pass unnoticed in the live animal. In very young pigs there may also be a brownish discoloration around the eyes. Accelerated respirations with some coughing may indicate pneumonia, which is frequently a complication of the disease, as is the case in swine fever.

Post mortem.—In acute cases the mucous membrane of the large intestine may show areas of necrosis or a diphtheritic type of inflammation, dark red in colour at first, and later the internal lining of the bowel may be covered with a yellowish fibrinous layer. There may be red striations along the length of the intestine, or patchy hæmorrhages, and ulcers are formed from the caseation of the lymphoid follicles. These ulcers are comparatively shallow with smooth edges and contain some necrotic debris. The smooth edge is the inflamed mucous membrane, which gradually extends towards the centre of the ulcer and assists in the healing process. The raised button type of ulcer found in swine fever is not encountered in this disease. The bowel wall may be thickened as a result of the caseous enteritis.

In addition to the bowel changes mentioned, there may be some enlargement in the spleen, and the presence of byperplastic spleen tumours has been reported, but this is not a constant finding in cases slaugbtered in the early stages of the disease. The lymphatic glands will show a blood congestion and some œdema of the mesenteric glands. Petechial hæmorrhages may be present in the kidneys, and these may often be so few in number as to be missed altogether. The skin lesions vary from none at all to a red discoloration of the ears, the skin behind the ears, buttocks, hams, and belly, or else some fine haemorrhages in the skin visible after scalding and scraping

off the superficial layer of epithelium and the bristles. Pneumonia, when present, is usually a complication of the disease, as also is peritonitis. The bowel lesions may extend forwards so as to cause a gastro-enteritis.

If an agglutination test is carried out, a titre of 1 in 100 is taken as a positive reaction. An allergic reaction may be produced by the subcutaneous inoculation of 1 ml. of a heavy suspension of the organisms, but for a certain diagnosis the *S. suipestifer* must be found at post-mortem. In acute cases the organism may be recovered from any part of the body, and in chronic cases it may be only in the mesenteric lymph glands.

Diagnosis.—As a rule the disease affects young pigs under six months old, but on rare occasions cases are found in adult animals. The latter are not so severely affected, and are often missed clinically, the lesions being only discovered at a post-mortem examination. Another distinction between this disease and swine fever is the fact that there is generally a history of overcrowding, bad feeding, or keeping pigs in an unfavourable environment where paratyphoid is concerned, but this is not always the case in swine fever, where imported animals may often bring the infection into a herd kept in first-class condition. The small skin ulcers on the shanks, found in swine fever, are absent in paratyphoid, whilst the bowel ulcers of paratyphoid cases are said to be distinguished from those of swine fever, in that the ulcers in the former disease are surrounded by a raised border of mucous membrane. In doubtful cases it is well to remember that the Public Health aspect must come first, and to suspect swine fever in a paratyphoid outbreak is wise. The differential diagnosis can always follow later.

Treatment.—A combined vaccine against *S. suipestifer, P. suiseptica*, and other pig organisms is available and offers promise of good results if combined with Sulfathalidine treatment plus attention to diet and general conditions, as there is no doubt that dietetic and avitaminosis errors are at the root of this disease. Nitritrofurazone (5-nitro-2-furaldehyde semicarbazone) in the form of a premixture of 11·2 per cent. nitrofurazone (one ounce of premixture to 14 lb. dry meal, gives a concentration of 0·05 per cent. nitrofurazone, which can be successfully used alone or combined with sulpha therapy)

Furazolidone is usually given in combination with nitrofurazone. Where it is not possible to attempt to carry out curative treatment, preventive treatment may consist in isolation of the infected pigs, the slaughtering of in-contacts, and a thorough cleansing and disinfecting of all pens, etc. Care should be taken to ensure that the ration is all that can be desired, that there is no weak link in the form of vitamin or mineral deficiency in the ration of the pigs and the breeding sows. Prior to entering the fattening pens the young pigs should have had access to pasture-land, plenty of fresh air and good food. If possible, the farmer sbould be advised to breed only from his own sows and not to import fresh store pigs. If it is found impracticable to do this, then all new stores should be isolated for a fortnigbt at least before being brought into the main herd. Warmth and comfort for the pigs appears to help in the prevention of this condition, as it does for many pig diseases. If nicotinic acid is fed daily in doses of about 150 mg. for adult pigs, it exerts a good effect, especially if treatment is commenced early in the disease and before the enteritic symptoms develop into dysentery. Both sulpha drugs and antibiotics exert a beneficial influence in the treatment of this condition by preventing complications and so assisting recovery. Subcutaneous injections of copper, iron, cobalt and vitamin B_{12} compounds are available for the treatment of the individual pig, and are well worth using.

Swine Erysipelas (also known as mal rosso, rouget du porc, Schweineretlauf, red soldier, purples, blue soldier, diamonds disease, etc.) is an infectious disease caused by *Erysipelothrix rhusiopathiæ*, which is a minute rod-shaped organism, non-motile and non-sporulating, growing as long segmented threads. It is Gram positive and grows on any of the ordinary media, giving the characteristic brush appearance in gelatin stab culture It is believed that the organism produces toxins within the animal body, although it does not do so in artificial cultures. The organism has been found in the alimentary canals of healthy pigs, and it can remain alive in the soil for long periods, multiplying in moist soil at summer temperature. The disease is most prevalent in the months from June to October. The predisposing causes of this disease are similar to those giving rise to many conditions in pigs—dietetic errors, bad housing and sanitation,

etc.; in other words, anything which may tend to lower the animal's normal vitality in any way. Pigs sent on a long journey by rail to an abattoir may leave their sties showing no symptoms of this disease, whilst on arrival at their destina-

FIG. 55.—SOME TYPICAL SKIN LESIONS OF SWINE ERYSIPELAS.

tion they may show marked symptoms and even death may occur if the journey is unduly prolonged.

The disease is contagious and easily spreads from pig to pig, the period of incubation being from three to five days. Man can be infected, too, and cases are known especially amongst butchers handling and slaughtering pigs, infection in

their case being usually through inoculation, a cut finger or scratch on the skin of the arms becoming contaminated with blood from an infected pig. Numerous cases of human infection have been recorded in Germany, some cases terminating fatally, whilst cases are also known in this country. Men affected may have a red, blotchy face and hands for some years. Occasionally the red blotches will form themselves into typical "diamond-shaped" markings of erysipelas, and tend to cause irritation when exposed to the heat of a fire Beyond some local irritation on occasions, none of the human

FIG 56.—SWINE ERYSIPELAS: HEART EXPOSED TO SHOW ENDOCARDITIS LESIONS ON THE VALVES.

cases known to the writer suffered any marked illness from their peculiar disease, although the diamonds persisted on their skins for some years. Little pigs under three months old are not so susceptible to infection as pigs from five to eight months old, nor do breeds show any particular variation in resistance. The disease is at its lowest ebb about the month of April.

Symptoms.—The acute, subacute, and chronic forms of the disease are generally recognized. A pig affected usually shows a loss of appetite, with a high temperature, followed by skin lesions in the form of slightly raised diamond-

shaped markings, or else distinct redness of the ears, the skin behind the ears, buttocks, hams and belly. Occasionally the skin markings take the form of larger diamond markings about 6 inches long on the flanks and backs. Scabs may form over these markings, later falling off, leaving a pitted surface which may extend into the subcutaneous fat. Pigs are usually constipated, and there may be some symptoms of pneumonia, but this latter is a complication rather than a characteristic symptom of erysipelas, but the lungs may be somewhat

FIG. 57.—KIDNEY HÆMORRHAGES IN A PIG AFFECTED WITH ACUTE SWINE ERYSIPELAS.

œdematous. At a later stage diarrhœa appears, and the heart may also be affected, the animal being disinclined to move, resting on its belly rather than its side. An apparently recovered pig may develop the chronic form in which the heart valves become affected by a vegetative endocarditis. Such animals may appear to recover from the disease for a time, only to be found dead unexpectedly later on.

The limb joints may be swollen, and the pig appears tucked up in the flanks and belly. Such animals are generally classed as being rheumaticky, and many of the so-called cases

of rheumatism in the pig are in reality old cases of swine erysipelas.

E. rhusiopathiæ has been found as the cause of arthritis in a large percentage of pigs in the United States. In one instance as many as 75 per cent. of market pigs affected with arthritis were found to be harbouring this organism. (See "Arthritis.")

Post mortem.—The most characteristic lesions are the

FIG 58.—SWINE ERYSIPELAS—CHRONIC VEGETATIVE ENDOCARDITIS.

diamond-shaped, raised red markings on the skin. In very acute cases there may be no diamonds, but a diffuse red discoloration of the skin extending over all the body, or else, depending upon the period of the illness, a number of ugly scars along the flanks and back, as though the pig had been caught in some barbed wire at some time and the skin badly torn. In the more chronic type of cases the lymph glands, notably the iliacs, are much enlarged and brown in colour. Congestion of the lymph glands occurs in acute cases, with some enlargement and congestion of the spleen, hæmorrhages

in the lungs and kidneys, and on the external surfaces of the stomach and intestines. The heart may show some endocardial hæmorrhages, and a verrucose endocarditis will be present on the heart valves. This starts as a tiny bleb, eventually enlarging so as to form a large growth on the valves, the mitral valve being the common site of the lesion. In pigs having apparently recovered from the disease this may be the only post-mortem lesion present, but the endocarditis lesion is not by any means so common as the skin lesions. In addi-

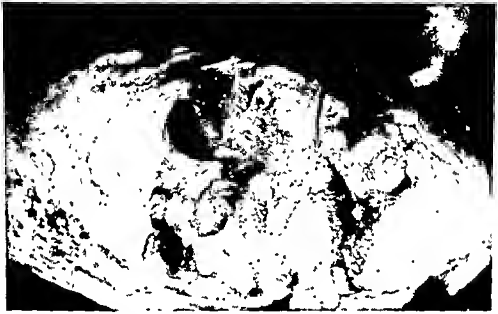


FIG. 59.—THE DISTAL CONDYLES OF THE HUMERUS OF A PIG AFFECTED WITH CHRONIC SWINE ERYSIPELAS.

tion, there will be some congestion of the mucous lining of the intestines, with some fibrinous deposits.

Diagnosis.—The diamond-shaped skin markings appear to be characteristic of swine erysipelas. These marks vary from the small inch-square diamonds to raised lines, again roughly diamond-shaped, on the skin of the flanks and back. These look as though a child had tried to draw rough squares on the animal's skin with a piece of red crayon, using lines 3 or 4 inches long. In other cases the skin appears as though the pig had been dragged through some barbed wire fencing. Difficulty arises when the acute and more diffuse colouration is present in the skin. I have already mentioned how the ear

swellings may be distinguished from the throat swellings of anthrax. A post-mortem examination may have to be carried out before establishing a diagnosis with any great certainty. The absence of bowel ulcers and diphtheritic lesions distinguishes erysipelas from swine fever and paratyphoid. Neither

FIG 60.—ACUTE SWINE ERYSIPELAS, SHOWING DIAMONDS OR URTICARIA SKIN LESIONS.
The raised diamond-shaped areas coalescing in some areas

splenic nor lung lesions are present in erysipelas, whereas they are invariably to be seen in the other two diseases. Although a streptococcic endocarditis is sometimes found in pigs, it is fairly certain that endocarditis plus skin or joint lesions, especially if the lymph glands are enlarged, friable, and brownish in colour, indicates swine erysipelas.

Treatment.—A recovered animal is said to be immune for life, and treatment usually consists in isolating the affected animals, the administration of laxatives in the early stages, and inoculation with large doses of antiserum. All in-contact pigs should be given a protective dose of antisera; this gives them an immunity for about a fortnight, and will assist in enabling the animals to be fattened up for slaughter. If a longer immunity is desired, a combined dose of vaccine and serum is given. The injections can be made quite conveniently in the tissues just behind the ears, and not in the thighs, as is often recommended. The ear site is preferable as, should any untoward sequelæ such as an abscess develop at the site of inoculation, little damage is done to the "expensive" parts of the carcase. It is also more convenient to the operator, as pigs can be grouped together in the corner of a pen, and kept there with a hurdle, whilst the surgeon can then carry out his inoculations in amongst the pigs without having to wait for each animal to be caught and held for him. If the pigs are crushed together in this way, most of them will have their heads up to see what is going on, and the pressure of their fellows prevents their running away. The author has found this a convenient and time-saving method when large numbers have to be vaccinated, and with an assistant handy to provide syringes and swabs for skin disinfection it is surprising how rapidly a whole herd of some hundreds of pigs can be dealt with in the modern type of pig-fattening house. Modern vaccines need only one injection to provide immunity. A large dose of serum plus penicillin injection is the best curative measure. The months of April and May are best for carrying out vaccination, as the disease is said to be at its lowest ebb during that period of the year.

In addition to inoculation and vaccination penicillin treatment is also effective. One should not lose sight of the predisposing cause, and an endeavour should be made to remedy any defects in diet, housing, etc., so as to prevent a repetition of this trouble. In this respect the addition of some skimmed milk to the diet will prove beneficial.

Swine Influenza.—A disease known as swine plague (Schweineseuche) has long been recognized in Europe and America, and it was believed to be caused by a Pasteurella

organism, the *P. suiseptica* or *P. suis* (*B. bipolaris suiseptica*). It is now known that the organism in question is a universal saprophyte in pigs. Later a disease has been described as occurring in piglets, and termed piglet influenza (Ferkelgrippe). This latter disease was believed to be caused by the organism *Hæmophilus influenzæ suis*, but it is now known that the organism is merely a secondary invader, and that both swine influenza and piglet influenza are caused by filtrable pneumotropic viruses. The predisposing cause in both cases would appear to be some dietetic deficiency or avitaminosis. Köbe and Fertig attempted to grow these viruses in tissue cultures prepared from the lungs of guinea pig fœtuses without success. They were, however, successful in cultivating the viruses on the allanto-chorionic membrane of the chick embryo, but they found that after cultivation in this way the piglet influenza virus lost its infectivity for the white mouse, whereas the swine influenza virus retained its infectivity. Schmidt, in a comprehensive review of these influenza diseases, concludes that swine influenza is an epizoötic disease of *adult pigs*, due primarily to a filtrable virus which is often associated with the so-called swine influenza bacillus, the lesions developing being localized in the lung and consisting of a bronchitis, peribronchitis, atelectasis, and bronchopneumonia, the primary reaction to the virus being a peribronchial infiltration.

Piglet influenza is regarded as being enzoötic in character and affecting only *young* pigs, the typical lesions being identical with those of swine influenza, but that the presence of the swine influenza bacillus is necessary for their production, the virus alone producing only a peribronchial infiltration. Shope found that under experimental conditions a mild form of the disease was produced by the virus alone, but that where *H. influenzæ suis* was present as well as the virus, a severe influenza followed. Dutch writers have found that *H. influenzæ suis* can be present in pigs for a considerable time without producing any clinical symptoms. Shope also made a study of the antibodies against swine influenza in the sera of human beings. He found that the sera of a high proportion of adults above the age of twelve years neutralized the swine influenza virus. Animals immunized or hyperimmunized

against the swine influenza virus yielded sera which sometimes afforded partial protection against human virus. The same worker also found that influenza virus may be present in non-infective form in the lungworms of pigs, and that it is rendered active by suitable provocation. Influenza was produced in 130 out of 216 pigs reared free of worms and then fed on earthworms containing infective lungworm larvæ. A more effective method of provoking the disease was by the intramuscular injection of *H. influenzæ*. Lungworm larvæ are said to remain infective for thirty-two months, whilst lungworm ova from recovered pigs have been found to contain virus. Shope has further shown that when earthworms containing lungworm larvæ from farms in which influenza appears annually in pigs were fed to experimental hogs, a proportion of the hogs developed influenza following injections of *H. influenzæ*. Some pigs removed from such a farm during the inter-epizootic period would show symptoms of influenza after provocation. The persistence of the virus in the period between epizootics and the simultaneous appearance of numerous outbreaks over a wide area may thus be due to earthworms acting as intermediate hosts for infected lungworms. The cold wet weather of the winter months appears to favour the onset of the disease, and whilst the disease may easily be provoked experimentally from January to April, a natural infection about November or December appears to render the recovered pig immune for the immediately succeeding months.

The swine influenza virus can be found regularly in the lungs, tracheal exudate, and in the turbinates of affected pigs, but does not appear to be found in the blood. Although this disease often occurs with swine fever and swine paratyphoid, an attack of swine influenza does not confer any immunity against swine fever.

Blakemore described an outbreak of swine influenza in East Anglia. He reported that young pigs were affected while older animals appeared to be resistant. The disease involved the turbinates, lungs and bronchial lymphatic glands. An organism of the *Hæmophilus* group was found in the lungs and the presence of a filterable virus was demonstrated. He reproduced the disease in pigs and ferrets and showed the presence of neutralizing antibodies in the blood of convalescent

pigs. The virus could be found in the lungs of a pig eight weeks after acute symptoms were shown; from this observation it seems possible that the disease may spread by the keeping of healthy stock in contact with chronic cases. He also describes further observations on the disease, in which he found the virus in the lungs of pigs, some at a public abattoir. Pneumonia was present in the lungs. He failed to find *Hæmophilis influenzæ* organism in more than half the pigs examined and in the lungs of which he demonstrated the virus.

Symptoms.—In cases not complicated by a specific fever respiratory movements are increased, with a cough and swelling of the throat. Discoloration of the ears, inappetence, high temperature, constipation, and an inclination to lie down quite a lot are other symptoms of this condition. Eye trouble in the form of a mucopurulent conjunctivitis is fairly characteristic. Dyspnœa and death may occur within a few days of the onset of symptoms. Lamont and Shanks have described cases of acute arthritis in pigs in Northern Ireland. One or more limbs were affected in each animal, and the condition was a very painful one, with high temperature. This form of arthritis has also been encountered in English pig farms, where it is called "cramp," but appears to differ slightly from the Irish cases in that it affects older pigs. Here the symptoms come on suddenly and are of a rheumaticky type, with lameness, usually one or both stifle joints being swollen, hot and painful. The pig adopts a sitting posture and resents being moved. Some cases recover, and show a wasting of the hind-quarter muscles. (See Arthritis.)

Post mortem.—The pneumonic lesions vary from a hæmorrhagic condition to an extensive hepatization of the lungs. It is often the anterior lobes of the lungs that are first affected, and the condition may be bilateral There may be an œdema of the lungs, and in advanced cases grey hepatization and fibrinous necrotic pneumonia, with an extension to the pleura, causing acute pleurisy and even pleural empyema with pericarditis. The diaphragmatic surface of the liver can also be involved. Also pharyngitis with œdema of the glottis and bronchial catarrh.

The bronchial, mediastinal and cervical lymph glands are enlarged, and the mucous membrane of the stomach and in-

testines slightly congested. In the arthritic cases inspissated serum replaces the normal synovia in the affected joints, whilst evidences of inflammation are found in the articular cartilages.

Treatment.—(See Pneumonia.)

Pneumonia.—As a tissue reaction to infection with bacteria and viruses, invasion by parasites or stress by other means,

FIG. 61.—PNEUMONIA: PIG LUNG SHOWING SURFACE CONGESTION, HÆMORRHAGES AND HEPATIZATION.

pneumonia in the pig is typical of the syndrome which is found in all other species of domesticated animals. The nature of the pig's environment, its nutrition and the production demands made upon it, together with the host-specificity of most of the causal agents, combine to exert, in the pig, a distinctive pattern marked by high incidence of local reaction. Acute and serious

signs of pneumonia are therefore relatively uncommon, but local lesions are found in anything up to 60 per cent. of pigs' lungs seen in abattoirs. The ætiological factors are numerous and considerable doubt exists, in spite of extensive research, regarding the status of each as a primary invader. The evidence afforded by Betts and others at Cambridge supports the role of a large virus as a causal factor of the condition now commonly known as *Enzoötic* or *Virus Pneumonia of Pigs (V.P.P)*, which was incriminated as the responsible factor in a great number of outbreaks of pneumonia in the field. Other workers who have studied the histological evidence from material taken from so-called V.P.P. lesions report that a typical picture can be obtained in a smaller number of cases than expected. The histopathological findings, which are very much more specific than macroscopic examinations for the various types of lung conditions, suggest that a number of different ætiological agents are responsible, either individually or in combination with each other. In addition to the viruses, these include organisms of the Hæmophilus group, salmonellæ, corynebacteria, streptococci, staphylococci, a pleuropneumonia-like organism which has not yet been accurately classified, pasteurellæ, *Mycobacterium tuberculosis* and parasites in the form of the true lung worm, *Metastrongylus apri*, and the larval stage of *Ascaris lumbricoides*. The clinical condition of pneumonia which may result from the activities of these organisms is not distinctive enough to enable the clinician to differentiate with certainty the responsible factor or factors. Nor can the post-mortem lesions be taken as infallible criteria. It is essential that the pathology of the disease be studied in the laboratory before an accurate assessment can be made. It should never be forgotten that the virus of swine fever may itself be responsible for only local lung lesions.

Pneumonia occurs in pigs throughout Europe, North and South America, Australia, and in fact wherever the species is reared for human food. Infection is believed to be spread through coughing pigs introduced into herds, and airborne infection in the case of the viruses has been proved by exposing susceptible pigs to infective mists. Affected animals do not always show visible symptoms beyond some unthriftiness and a nursing sow may pass the infection to the young pigs, whilst

these in turn spread it through the herd when mixed together after weaning. A pneumonic syndrome may be found in many little pigs showing only unthriftiness. The condition may occur as a complication of many other pig diseases and is especially liable to occur on those farms where there is some overcrowding of pigs, with faulty ventilation of buildings. The chief predisposing factor is wide daily fluctuation in temperature. Scandinavian types of pig houses are particularly difficult to ventilate properly if they are at all large, and down-draughts in the pigs' sleeping quarters must be avoided at all costs. Pigs can stand a lot of discomfort when they are up and about, but they do like a dry, warm sleeping-place, with adequate bedding and sufficient insulation to maintain a steady atmospheric temperature and humidity.

The infective agent in V.P.P. is a large virus which can survive at room temperature for at least 24 hours in a buffer solution. It persists for a long time in an affected lung, and Betts, at Cambridge, has recovered the virus by the inoculation of susceptible pigs from a pig known to have been infected 66 weeks previously. Once the disease is introduced into a herd, it persists from one generation to another and so tends to remain endemic. The nature of hæmophilus infection has already been described under the heading of Swine Influenza, and better understanding of the methods whereby this organism may be isolated from pathological material is assisting research workers in demonstrating its presence more commonly than hitherto. The other organisms are all capable of survival for a considerable time and often inhabit the respiratory tract of apparently normal animals. *All these factors tend to enhance the difficulty* of eradication of the disease once it has been controlled on a particular farm.

Symptoms.—In the more chronic or subacute form there is little to note beyond a general unthriftiness. The affected animal does not appear to thrive like its litter mates. A cough may be detected when the pig is disturbed or after some exercise, particularly when coming out for the first morning feed. Whilst a pneumonic pig may cough, it should not be assumed that all pigs which cough necessarily have pneumonia or other respiratory involvement; in any case the cough does not persist for long. As the disease progresses, the coat shows the rough-

ness and lack of bloom usually associated with the unsound pig. The animal remains recumbent a great deal and respiratory movements become more pronounced, a distinct line being traced along the lower end of the ribs as the flank muscles are brought into play more and more. Cyanosis, as evinced by dark discoloration of the ears, is seen in bad cases where the lungs are extensively consolidated. Frequent complication with pericarditis and pleurisy has been noted, with a resultant emaciation.

In the more acute stage, the animal may not have shown any signs in life of any disease. It may even feed normally, only to be discovered dead some hours later. In such cases there may have been some symptoms present which were unnoticed by the attendant, as old-standing pneumonic lesions have been found in the lungs of pigs with histories of sudden death from no apparent cause. Temperature is not a reliable guide; in some cases complicated with pleurisy and even pericarditis there is a marked rise in temperature, but in most other circumstances the temperature remains unaltered. As the disease progresses, extension of the inflammatory process to other parts of the body, particularly the peritoneal cavity, may occur. Some pigs, usually under 18 weeks of age, tend to carry their heads on one side, walk round in circles and generally give the impression of brain affection. Others may be found kneeling, or propped with their sides against a pen wall. It is only when the pig is almost *in extremis* that it lies stretched out on its side, mouth open, gasping for breath. In white-coloured pigs, cyanotic discoloration of the skin behind the ears, on the shoulders and along the abdomen can be seen at this stage. Pneumonia can develop in pigs of all ages but is most common in housed pigs below slaughter age Some of the bacterial infections produce an acute but sporadic disease, while the viral agents tend to produce a subacute or chronic comparatively mild but widespread disease, in which severe signs are produced by the superimposition of a secondary bacterial invader.

Post mortem.—Pneumonic lesions of varying kinds are generally found involving the anterior lobes or the edges of the other lobes as a rule. Where the onset of the disease has been rapid, lesions are not usually numerous and take the form of a well-demarcated area of congestion near the base of the lobes,

with some hæmorrhages distributed in the lung parenchyma. The degree of lung involvement often bears no relation to the severity of symptoms in life, pigs with two-thirds of their lungs showing hepatization having exhibited fewer symptoms than one with only local congestion. The consolidated area is usually dark red in colour although in some cases, *e.g.* lung lesions of swine fever, the histological picture presents a state of atelectasis with little or no inflammatory reaction. The various bacterial agents and others mentioned above may invade these primary lesions or produce primarily themselves an extensive pleurisy, pericarditis and peritonitis. Empyema occurs in pigs where treatment is neglected and particularly where the animal is a weakling from the start; in such cases diarrhœa and even dysentery may be seen before the animal succumbs.

In older pigs there may be a few areas of consolidation, but a thickening of the lung septa with some fluid in the air spaces is commonly seen and is associated with the "asthmatic" kind of case particularly in old "razor-backed" unthrifty sows.

Treatment.—The success of any treatment will depend upon the cause of the condition. As the veterinary surgeon may be unable to differentiate on clinical grounds, treatment is often a matter of empiricism. The sulphonamide drugs are effective against most of the bacterial forms of the disease, and as these are the more serious this therapy should always be applied when pneumonia is diagnosed. Sulphapyridine or sulphadimidine (sulphamezathine) solutions are preferably given intravenously by injection into the anterior vena cava. The latter drug may, as an alternative, be given by subcutaneous or intramuscular injection. The dosage is approximately 1 g. per 10 lb. body weight and needs to be repeated daily for several days. Oral administration of any preparation should be avoided, especially in an animal showing marked respiratory disease. Antibiotics such as penicillin, streptomycin, Streptopen and others seem to exert a synergistic action when used in combination with the sulphonamide therapy, but no drug exists at present which has any significant effect upon any of the viruses associated with pneumonia, but chloramphenicol has been used in deep muscular injections, with good results.

The affected animal, which will have been isolated immediately the disease was detected, must be comfortably housed

and allowed as much access to air as possible. Milk or other liquid food should be offered in small quantities and frequently if the animal is able to take food at all. On no account should forced feeding be practised; if resolution is going to occur, the animal is better able to survive on its own reserves than be subjected to the risk of inhalation of food material.

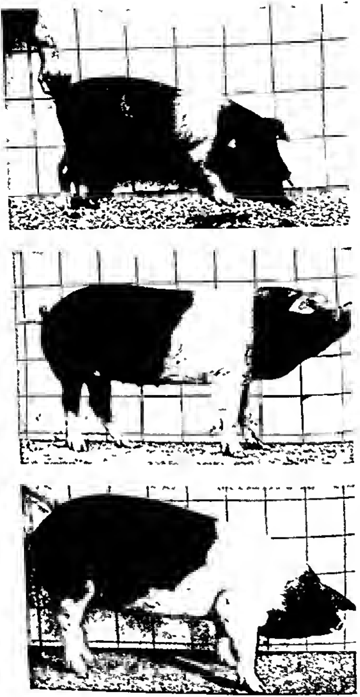
Preventive treatment is of the utmost importance and here again, warmth and freedom from draught and moisture in the sleeping pen are essential, particularly at night when the pigs are not likely to be moving about. Overcrowding must at all times be avoided and a balanced ration of food supplied containing the essential mineral and vitamin supplements. Clean, dry bedding is also necessary, but where the houses are arranged to avoid collection of moisture, and maintenance of a satisfactory temperature of 70°F. or more, without fluctuations of more than 10 to 15 degrees on either side (as in the McGuckian system), the provision of large quantities of straw or other bedding can be reduced to a minimum. Few farms possess an isolation pen, which is of such fundamental importance in the control of an infectious disease. At the very least an improvised pen should be constructed in a strictly isolated position and made of materials which can be disinfected or destroyed completely by burning. The congregation of ailing animals in one place is also of great assistance to those who have to treat and nurse them.

A method of eradicating V.P.P. has been described by Dr. Betts of Cambridge, who suggests that the sow should farrow down in isolation in a clean pen or in a farrowing crate which is disinfected and left empty for a week after use. If the sow is a carrier of the disease, the piglets will soon show evidence of infection when scouring and coughing occur. If all goes well, the young pigs should be reared in isolation from the rest of the herd and all coughing sows slaughtered off. By breeding only from healthy stock, a pneumonia-free herd may gradually be built up, but strict measures must at all times be adopted with regard to isolation and disinfection. The "suspected" stock can be fattened together and antibiotic supplements will help to improve their appetite. The administration of a course of sulphadimidine injections by a veterinary surgeon will often help in converting a rather poor type of pneumonic pig into a

assable carcase for pork or bacon, the cost of the therapy being iore than met by the improvement in the finished pig. With he co-operation of the Cambridge Veterinary School, efforts ave been made to establish a register of V.P.P.-free herds.[1]

Differential Diagnosis.—The clinical manifestations of pneu-ionia resulting from infection with each of the various organ-ims mentioned above have much in common. Certain dif-erences, however, may be of assistance in distinguishing each ype. In Hæmophilus, the disease is sudden in onset and in ecovery, a marked febrile reaction being present. Several nimals may be affected. Although more sporadic, Coryne-acterium causes a similar picture which is enhanced by a pro-und toxæmia and is much more serious in effect. With most f the bacterial agents, pleurisy is a common complication and ie marked consolidation, together with the intrathoracic pain, ads to suppression of the cough reflex. The high temperature ay cause initial constipation which is followed by diarrhœa alimentary involvement occurs. V.P.P. is a comparatively ild disease with little temperature reaction but characterized a more pronounced and, for a time, persistent cough. It iows a marked tendency to spread and whole groups of animals ay be affected. As a clinical entity it is usually subacute or ironic and associated with some unthriftiness. As a rule ie parasitic infestations are never so heavy that they cause ieumonia by themselves. Husky coughs are present, but no mperature reaction is seen. The secondary invasion of the ng damaged by the parasitic load is, however, a distinct possi-lity and the pneumonia which follows presents a familiar ittern. Heavily parasitized pigs may be unthrifty, but it is uch more likely that bad husbandry and nutrition are respon-ble for poor condition and the subsequent lung and intestinal festation than that the parasites are responsible for the poor riving. In so-called "bowel œdema," respiratory involve-ent produced by œdema of the lungs may suggest a pneu-onic syndrome. The respiration is, however, gasping and spnœa is marked, particularly on inspiration. There is no ugh nor temperature and other parts of the body, *e.g.* the elids, will show the characteristic œdema. The course of the sease is rapidly fatal. Pneumonia often accompanies swine

[1] Association for the Advancement of Virus Pneumonia Free Pigs.



[Dr. A. O. Betts, Cambridge.

FIG. 62.—VIRUS PNEUMONIA.

A. A natural case with secondary infection. This pig weighed only 38 lb. when 131 days old.
B. A severely affected pig, which weighed only 126 lb. at 24 weeks of age.
C. Another 24-week-old pig, a litter mate to the one shown in B, but free from pneumonia. At 24 weeks this pig weighed 198 lb.

fever, and swine paratyphoid, but the general symptoms of each septicæmia will be noted, and will assist in the differentiation.

The chronic soft cough of the individual pig suffering from tuberculous pneumonia and pleurisy and showing general body wasting should be remembered, but fortunately this condition has been reduced to rare proportions.

Blackquarter (blackleg, emphysematous gangrene, symptomatic anthrax).—This is usually an acute infective fever of cattle and sheep, but has also been encountered in the pig, sometimes as a distinct disease and also as a mixed infection with malignant œdema. The disease is characterized by the degree of fever it causes, and by muscular crepitating swellings in various parts of the body. The muscles in the region of the shoulder and stifle are often the sites of the gaseous swellings, but they may occur in any other part of the body, and even along the alimentary canal, internally.

The organism responsible for this disease is the *Clostridium chauvœi*. In cattle and sheep infection usually comes from animals grazing on poor land such as hilly moorland or low-lying damp, boggy soil. Infection may enter the body from dirt in castration wounds, or from infected small cuts about the feet or gums around the teeth. *Cl. chauvœi* is a slender, actively motile anaerobic bacillus from 2 to 6μ long by 0·5μ to 0·8μ wide, with rounded (drumstick) ends, and sometimes a circle of flagellæ. It loses its mobility if exposed to oxygen, and spindle-shaped spore-bearing forms develop. It stains with the usual dyes and is Gram positive in the non-degenerate, young forms, being Gram negative in the older types. In bouillon and in the tissues the organism produces a rancid-smelling gas. The organism can be demonstrated in the blood soon after death.

Symptoms.—The most characteristic symptoms are the swellings which develop in the body musculature of the quarters, giving rise to the name Blackquarter. In the pig these swellings are sometimes present in parts of the body other than the quarters, such as under the jowls. The skin over the swollen part will show up as a very red, angry-looking swelling which may turn black in colour as the skin is about to slough off over the part. This swelling is due to the œdema and emphysema of the muscles affected. Similar œdematous

swellings may occur in the pharynx and any part of the alimentary canal, but they are found most commonly in the sites already mentioned on the outside of the body. The body temperature is raised and as the disease progresses the œdema spreads to the surrounding tissues. Muscular tremors, and congestion of visible mucous membranes, with every indication of an acute septicæmia, are followed by a drop in temperature to below normal, and death. Recoveries are not unknown, but the disease has a high mortality rate in young animals.

Post mortem.—A characteristic of the disease is the rapidity with which carcases putrify. The gaseous swellings appear most pronounced, and the gas may have penetrated the inter-connective tissues of the limbs causing them to swell up. Over the swollen muscles of the quarters, or other part affected, the skin appears gangrenous. Cutting into such a swelling the rancid butter odour of the gas is most marked, whilst there is a good deal of bloody serum oozing into the part. When this is removed the underlying muscles are darker in colour than normal, and spongy. In an early case, when there is often a joint infection with *Cl. chauvæi* and *Cl. septicum*, a slaughtered carcase will show the muscles of the swollen part very dry and paler in colour than normal. There is some congestion and swelling of the liver, and often necrotic foci in the substance. The spleen is not usually swollen, but bloody serum may be present in the abdominal and thoracic cavities. As has been already stated, the gaseous swellings may be found internally, in the muscles of the pharynx or occasionally in the stomach wall. The kidneys may be congested, as are the carcase and other lymph nodes.

Treatment.—Vaccination is usually practised on cattle and sheep, as is serum treatment. The disease has not been regarded as primarily a pig disease, although cases have been recorded in the pig from time to time, so that serum treatment would appear to be the logical answer to the disease in the pig also. Serum treatment plus repeated antibiotic treatment is indicated here, although the rapidity with which the disease develops in the body makes it difficult to encounter cases in sufficient time to enable any treatment to be successful.

Differential diagnosis.—The disease resembles anthrax in

many ways, but in anthrax the blood does not clot, is dark in appearance, and not frothy as in blackquarter. Nevertheless the septicæmic appearance of a carcase post mortem makes it imperative to examine smears microscopically before pronouncing judgment. The peculiar rancid smell of the gas in blackquarter is characteristic. There is also an absence of any gelatinous swelling in the neck in particular. The swellings in blackquarter being distinctly emphysematous, malignant œdema is easily mistaken for this disease, and *Cl. chauvæi* and *septicum* may be present in the one carcase, causing a joint infection. Again, the crepitations are not so distinct in the malignant œdema carcase as in blackquarter, nor is there so markedly rancid a smell present.

Malignant Œdema.—This disease is common to both animals and man, and it generally follows infection through punctured wounds where dirt has been allowed to enter. In pigs the anaerobic *Clostridium septicum* (vibrion septique) has been isolated by Steward in Britain, and the disease has been reported from various European countries as well as the United States of America. Infection may be from wounds or through the food. Pigs often fight and scratch the skin in the region of the neck, which is a frequent site of one of the main lesions of the disease. Steward suggests that reduced vitality owing to the presence of the swine fever virus in the animal's body may lead to infection with the *Cl. septicum.* In spite of the frequency of castration operations in pigs infection through that source is not common, but cases have been seen where young boars are operated upon at about five months of age, and the wounds afterwards neglected. Dirt is the main cause of the trouble, and particularly where dirt gets into a small punctured wound, say on the pig's foot.

Cl. septicum is found in rod-shaped forms with slightly squared ends. They usually appear singly, but end-to-end pairs can also be seen. The oval spores vary in their position and give a spindle shape to the organism. There are flagellæ as in *Cl. chauvæi*, and a gas with a disagreeable odour is also produced. The organism is an anaerobe and its spores are very resistant, being continually present in dust, dirt and animal intestines. In size *Cl. septicum* resembles *Cl. chauvæi* (blackquarter).

Symptoms.—A red or purple tumified swelling appears on some part of the pig's body, often in the neck and under the jowls, behind the ears, on one or other of the legs, under the belly or in the muscles of the flank. The temperature rises and the animal refuses its food. The swelling may be mistaken for an abscess, but the reddish colouration of the skin makes the swollen area appear more like an erysipelas type of reddening. There is not usually any marked crepitation, as is the case in blackquarter. Where infection has been through the food, the pig may vomit, it lies down and refuses any food whatsoever. Death takes place within about 24 hours, and very often the symptoms mentioned are unnoticed until the finding of a dead pig in the pen. Pigs of any age are susceptible.

Post mortem.—Cutting into the swollen part reveals a hæmorrhagic, œdematous muscle or muscles, and if there has been some delay in making the post-mortem examination it will be noticed that putrefaction has set in very rapidly in the affected part. There is some emphysema also, but this is not always so marked as one would expect. The lymph nodes draining the affected part are swollen and congested. *Cl. septicum* can be demonstrated in smears from the swollen muscles and lymph nodes. The liver is swollen and emphysematous, whilst if the alimentary tract is involved, lesions may be found in the stomach wall, with some necrosis, and hæmorrhages in the peritoneum.

Treatment.—Owing to the rapidity with which the disease progresses, and the fact that it is often only discovered when a pig is found dead, little has been done about curative treatment. Antisera would be the most useful line aided by antibiotics and the treatment of any visible wounds in the skin. Pigs should be prevented from wallowing in filth, and wounds on the feet, etc., should not be neglected.

Differential diagnosis.—The resemblance to anthrax in the pig is most marked, and smears should be examined microscopically. The anthrax swelling is of a more gelatinous kind than that found in malignant œdema, but the ease with which *Cl. septicum* can be demonstrated should prevent any mistake.

There is also a resemblance to blackquarter which is caused by *Cl. chauvæi*. The crepitation felt in the malignant œdema swellings is not so marked, nor is there the pronounced

rancid smell in the diseased muscles as in blackquarter, nevertheless both diseases may be easily mistaken for one another, and in the pig one is apt to be faced with a joint infection with *Cl. chauvæi* and *Cl. septicum*.

Rheumatism.—This condition is of obscure origin, and there is no doubt that many of the rheumaticky conditions met with in pigs, notably in those under a year old, may be manifestations of infection with the swine erysipelas organism. Rheumatism affects the fibrous tissues of the body, joints, tendons, ligaments, bones and muscles, and of the three conditions of rheumatism generally recognized as acute rheumatism or rheumatic fever, muscular rheumatism, and chronic rheumatism, it is the two latter conditions that are usually encountered in pigs.

When acute articular rheumatism is found in pigs it is usually due to an infection with the erysipelas organism, or invasion of the body by some specific infection. The predisposing causes of rheumatism are damp, cold, humid conditions, lack of sunlight, chronic constipation, etc.

Symptoms.—There is some acute pain and a disinclination to move. The temperature may be elevated, with abdominal respirations. The limb joints are swollen, and in cases where there is no swelling of the joints the animal may squeal when pressure is applied to the muscles along the spine. Appetite is either lost or very poor, and the pig is constipated, the urine being reduced in quantity and slightly thicker than normal. The symptoms may vary in severity from day to day, the animal appearing much better on some days than on others.

In more advanced cases there is some distinct skeletal change. The animal appears to be longer in the legs than its litter mates, or some spinal deformity is present. The elbow, stifle, and hock joints can be very swollen, causing some difficulty in movement.

Post mortem.—In acute cases the endocarditis lesion of swine erysipelas or a pericarditis may be present. No change will be visible in the internal organs or lymph glands. In other cases the lymph glands at the iliac and axillary region may be swollen and brown in colour, very soft in consistency. Where joint swelling is found, the synovial fluid is increased and turbid. The synovial membranes are

thickened, the articular cartilages eroded and may be replaced by fibrous tissue. An exostosis of bone involving the ligaments is rarely found in pigs, as the animals are often slaughtered before the condition arrives at this stage. No changes are apparent macroscopically in the muscles, but in muscular rheumatism the fibres show microscopic changes with cloudy swelling and disintegration and an increase in the intermuscular connective tissue. Some of the spinal muscles may be almost completely replaced by fat and connective tissue.

FIG. 63.—ARTHRITIS. INSPISSATED PUS AND GRANULATION TISSUE IN A FORELEG ABSCESS AFFECTING A GILT.

Treatment.—The diet should be overhauled and special care taken that there is no deficiency of vitamins. Some laxatives should be administered, and a dose of swine erysipelas serum will often prove beneficial. Concerning drugs, salicylates, salol, and sodium bicarbonate are often used. Calomel is useful as a purgative. Massage with liniments containing ammonia, turpentine, camphor, etc., may give some relief when the muscles of the spinal column are affected. Warmth and a dry sty with plenty of clean litter, and some exercise during sunny periods, should be allowed. Since rheumatism is believed to be a symptom or collection of symptoms of various condi-

tions, the predisposing cause should be ascertained where possible and eliminated; in this respect, housing, feeding and general conditions under which the pigs are kept should be carefully enquired into. Some arthritic conditions in pigs have been associated with an organism resembling *H. influenzæ suis*, *E. rhusiopathiæ*, staphylococci, streptococci, *M. tuberculosis*, and an unidentified agent reported in the United States, and which may or may not be a virus. (See Arthritis.) Good results may be obtained from treatment with penicillin, *S. erysipelas* serum, sulphapyridine, the injection of 30 ml. of a 20 per cent. solution of soluble sulphonamides in 1·5 gramme oral doses three times daily. Sulphadimidine in tablet form or in solution is also very effective in many of these so-called rheumatism cases. The dose for a sucking pig should not exceed ½ gramme per day, or about 3 or 4 ml. of a 16 per cent. solution.

Particular attention should be paid to an examination of the feet, as the animal may be suffering from laminitis. In that case, the temperature will be elevated. Laminitis will respond to treatment with antihistaminics. Adrenocorticotrophic hormone (ACTH) is useful in arthritis with febrile symptoms. Acetylsalicylic acid in tablet form, or compounds of acetylsalicylic acid, phenacetin and caffeine, are also good.

Tetanus.—Lock-jaw or tetanus is a specific disease caused by *Clostridium tetani*, an anaerobic, rod-shaped bacillus, forming spores which appear at the end of the rod, giving it the well-known drumstick appearance. The organism lives in the soil, and is said to be frequently present in the fæces of cattle and herbivorous animals, and to be found in the alimentary canal of all animals. It is found more frequently in tropical climates, but is widely distributed in all countries, and is said to be more prevalent in cultivated soil than on uncultivated land. *Clostridium tetani* forms an extracellular toxin (*tetanospasmin*), and another (*tetanolysin*) causes hæmolysis of the erythrocytes. The maximum period of toxicity is reached after cultures have been incubated for from ten to fourteen days, after which the toxic power deteriorates

All animals and man are susceptible to the disease, which usually originates from an infection of a wound, a castration wound, or a small wound about the head, face or foot (*trau-*

matic tetanus). Where no wound is visible, the infection may occur from internal damage to the intestinal wall by worms, the so-called *idiopathic* form of tetanus. The period of incubation varies from four to about fourteen days.

Symptoms.—Stiffness in the head and neck region is usually the first symptom noticed in the pig, with some frothing at the mouth and a peculiar curling of the ears in the upright eared breeds in particular, although the course of the disease may vary according to the site of inoculation, as the organism remains at

FIG. 64.—THE SCROTUM OF A PIG INFECTED WITH TETANUS AFTER CASTRATION.

the site of entry into the body and produces a toxin which travels by absorption via the nervous system. In the case of infection from a castration wound secondary invaders will have caused the formation of a purulent condition in the wound with abscess formation. The pig will move with difficulty and may be unable to feed, showing nervous excitement. The temperature is raised and respirations accelerated. The head is held very stiffly, the eyes sunk in their sockets with the membrana nictitans easily visible. Trismus or locking of the jaw

may occur, making feeding impossible. There is some constipation, and pneumonia. A hard tense feeling is conveyed to the fingers when gently pressed along the parts of the body affected. In opisthotonos, when the muscles of the back are affected, the head and tail are raised, and in emprosthotonos, when the abdominal area is affected, the back is arched, head and tail depressed. In pleurothotonos, the flank area being the part affected, the muscular contractions may produce a lateral curvature of the body. Death may occur from exhaustion.

FIG. 65.—TETANUS FOLLOWING CASTRATION

Post mortem.—Lesions are few; there may be an abscess at the wound, with some congestion along the nerves leading from the part to the spinal cord and medulla.

Treatment.—Prophylactic treatment should consist of the injection of antitetanic serum. Care should be exercised when performing castration that the wound and instruments used are clean. The animals should be removed from land which is affected with tetanus organisms until the castration wounds have healed. Isolation in a quiet dark pen and injections of large doses of antitetanic serum may prove beneficial.

The site of infection must be rigorously cleansed and to control the tetany, chlorpromazine injections are also recommended in this disease, but once the symptoms are firmly established, treatment is of little avail, and it may be best to slaughter the animal.

Brucellosis of Swine.—Outbreaks of abortion in sows have been reported from America, Europe and Russia, attributable to *Brucella suis*. Whilst the disease is regarded in the United States of America as a chronic infectious disease, in Great Britain there are no reports of extensive outbreaks of abortion in sows due to this organism, but it is known that Brucella infection in sows does not always produce abortion, nor is the infection in pigs anything like so extensive as in cattle. Many cases of abortion in sows here in Britain appear to be due to either a lack of vitamin E in the food or to some physical causes, such as injuries, but there is no doubt that some of the symptoms described in the United States veterinary literature as being characteristic of brucellosis are also found in pigs in this country.

The decrease in the pig population of Britain due to the recent war has had one beneficial result in preventing the overcrowding of pigs on pig farms. In pre-war years this over-stocking was a prime cause of many pig diseases, and so we have in this country a freedom from many diseases which still cause havoc in the large herds of the United States. Large-scale work on *Br. suis* in Britain is required before we can state positively that our herds are free from this infection. When Doyle carried out his tests for *Br. suis* in 1943 he tested over 10,000 samples of sows' blood, finding that only four gave a positive reaction in dilutions of 1 in 25, seventeen in dilutions of 1 in 50, and four in dilutions of 1 in 100.

Br. suis has also been found in cattle, in the udders of cows, and is reported to be more virulent for human beings than Bang's bacillus. Unlike the latter, *Br. suis* has not been reported as causing fistulous withers or poll evil in horses, and infection is rare in poultry and cats, but dogs may harbour the organism from eating infected material. Although *Br. abortus* has the greatest opportunity of infecting man, *Br. suis* is more virulent, and people handling infected material should be most careful, as invasion of the body by the germ is usually through skin abrasions. The symptoms in man are similar to those of undulant fever caused by *Br. melitensis*.

The disease brucellosis of swine is characterized by abortion, stillbirths, weak pigs, sterility, joint swellings and posterior paralysis. The boar is more susceptible to infection than is the bull, and testicular swellings with a progressive sterility follow. A new boar introduced into a herd can thus infect the sows served. Infection can also come through the milk of the dam, through contaminated food and premises. Owners of pig herds visiting markets and sales may carry infection, whilst the feeding of raw garbage and offal is also suspected as a means of carrying the disease to clean herds. The organism affects pigs of all ages, and whilst they are very resistant to *Br. abortus* infection, *Br. melitensis* (goat) has been recovered from pigs. *Br. suis* has been recovered from the blood stream of pigs, and in young swine the average blood stream infection lasts for one to six weeks, although instances are known where the infection has persisted for eight months.

Pigs exposed to massive doses of a polyvalent suspension of *Br. suis* by the rectum, mouth, conjunctiva, vagina, prepuce, subcutaneous and intravenous routes, showed that a high proportion were readily infected at weaning age. Gilts infected with the organism as weaners may carry their young to full term in their first pregnancies, and *Br. suis* cannot be recovered from them or from the tissues of their new-born pigs. Usually after running a course through a herd, the infection tends to be eliminated through the recovery of the animals, and their sale for slaughter. The organism may persist in the blood stream of sows for as long as thirty-four months. It may persist indefinitely in the uterus as a chronic metritis, causing sterility, but more often the uterine infection is resolved in from two to four weeks after abortion or parturition. The bone and joint infections are generally of a chronic nature, whilst the udder infection may persist for life in some cases, and disappear in others before the succeeding pregnancy. In the boar infection of the testes and the seminal vesicles may persist indefinitely. The organism is eliminated from the body through the discharges and secretions.

Symptoms.—A dirty discharge from the vagina will be noticeable some hours before the act of abortion takes place. The little pigs are either born dead, or there may be a few live pigs with a few dead ones, but the chances of survival of the

live pigs are poor, and they die off within a short time of birth. The act of abortion usually takes place during the third month of pregnancy, and often within a week or fortnight of the date normal farrowing is expected. The membranes and discharges from the uterus are dark brown and stinking, especially if the little pigs have been dead for some time. On the other hand, some sows, although infected with *Br. suis*, will farrow normally, but the litters will be small in number. Others may farrow dead pigs at the normal period, or give birth to a litter of weak pigs. Sterility follows infection, and is often accompanied by a weak watery discharge from the uterus. Infected boars show swellings of the testicles, in one or both organs, and on castration of little pigs, adhesions of testicles to the scrotum have been noticed. The leg joints may show swellings, the animal's gait is impaired when the spine is affected, and posterior paralysis is also due to the same cause. The organism can be recovered from infected placental membranes as well as from aborted pigs.

Post mortem.—Most of the lesions are confined to the genital organs. In boars the testes will be swollen. Adhesions in the scrotum of young hogs may not necessarily indicate *Br. suis* infection, as these are found in old cases of peritonitis. Abscesses have been described as occurring in the liver, spleen, subcutaneously, and in the tendon sheaths, but these are rare, and are not characteristic of this disease. Lesions in the liver, when they occur, are barely visible to the naked eye. Caries are found in the spine; in cases where there was posterior paralysis, the caries may be extensive. Limb joints show swellings of an inflammatory nature, but similar lesions are found in certain cases of swine erysipelas, rheumatism, tuberculosis, and other diseases. Metritis is a characteristic lesion in the sow, but the disease will even persist in a herd in such a mild form as to show few symptoms or lesions.

Treatment.—The presence of *Br. suis* can be demonstrated microscopically from the placental membranes, etc., and a blood sample may be submitted to the agglutination test in order correctly to diagnose the condition. As *Br. suis* does not produce agglutinins in uniform amounts, the agglutination test is not so valuable as it is in cattle. Some pigs will give titres of 1 in 25, and even 1 in 50 in clean herds. The test is

more valuable in diagnosing a *herd* infection than for individual pigs. In America it is considered best to blood-test all the animals in the herd, and if titres of 1 in 100 or over are found, the herd is considered infected. If no animal shows a titre of 1 in 100 or over on two tests carried out from thirty to sixty days apart, and there is no previous evidence of infection, such as abortion, sterility and weak litters, with no additions made to the herd from outside within the last three months, then the pigs are considered to be free from infection. The use of Brucellergen, made from *Br. suis*, as an intradermal test, gives a more sensitive reaction, but it also gives more non-specific reactions than the blood-test. The two tests are useful in combination. A vaginal mucus agglutination test may also prove a valuable aid.

Drug treatment is of little use, nor is Strain 19 vaccine of any use in this pig disease. Vaccination with the King strain, which is a low virulence strain of *Br. suis*, increases resistance to natural infection for a few months, but this resistance is lost in two years. There is no proof that the King strain will not return to full virulence in some animal, and so actually set up an infection. Treatment should include the provision of a balanced ration with access to green food, whilst vitamin E can now be obtained in the form of wheat-germ oil. Other vitamins may also be used in capsules, and are said to have good effects in preventing abortion, sterility, and small litters, etc. In the case of the disease assuming large proportions here it may become necessary to submit every breeding sow and boar to a blood test. Hygienic precautions should be taken, whether the abortion is due to *Br. suis* or not. The pens should be disinfected and sows isolated and fattened off for slaughter. New animals introduced into the herd should undergo a period of isolation.

The aborted sow's uterus may be washed out with a warm mildly antiseptic solution and a pessary inserted. Any dead fœtuses and membranes should be burnt, and the farrowing pen thoroughly cleaned out and disinfected, litter also being burnt. The pen should be kept empty of pigs for some time afterwards.

The various vaccines and inoculating fluids widely advertised for the prevention of contagious abortion in cattle are of little use in this condition as it affects sows. Great care should be

taken to prevent the pregnant sow from being injured by other sows, and she should be allowed plenty of exercise at grass. The diet should be properly balanced and some wheat germ oil, containing vitamin E, may be given, with plenty of green food. An aborted sow can become pregnant and farrow normally at the next period, but there is always a risk of the sow proving sterile, and it is sometimes advisable to fatten the animal up for slaughter rather than risk another abortion.

The lack of an efficient diagnostic agent makes it difficult to estimate the extent of the disease, and the control measures suggested in the United States include the blood testing of all replacements, with isolation. New stock should be purchased only from clean herds, and after a three months' isolation, new stock should be retested before being mixed with the herd. This is especially important where new boars are concerned. The American plans for cleaning up infected herds are two; one for breeding herds consists in separating weaners negative to the blood test from the infected herd, and the disposal of the infected herd. The second plan is for small herds and commercial herds. This is the drastic one of disposing of the whole herd, cleaning and disinfecting the premises, and replacing with pigs from a clean source.

Bowel Œdema.—This condition is also called Gut Œdema, and although it has come into prominence in the last decade it is by no means a new disease of pigs. The older practitioners recognized this condition under the name Impaction of the Stomach, or Stomach Staggers in the pig. These latter names are taken from the most prominent lesion found at a post-mortem examination in pigs which have died suddenly from the disease, or from one of the chief symptoms of the staggers in the live animal. With the great increase in the pig population with its accompanying overcrowding and the rushing of pigs through to slaughter weights as early as possible, this condition has once more come into prominence, and in a more severe form than was the case years ago. The œdema disease has been described by Shanks as long ago as 1938, also by Lamont, Luke and Gordon, but the classical work on this ailment was done by Timony. A hæmolytic type of *Escherichia coli* has been recovered from the intestines of affected pigs, and whilst intravenous injections of one serotype from a

field outbreak produces the condition, hæmolytic *Esch. coli* from the pig diseases do not lead to œdema disease. Sojka, Erskine and Lloyd tend to regard this œdema disease as an enterotoxæmia associated with specific serotypes of hæmolytic *Esch. coli* organisms. Gitter also recovered strains of *Esch. coli* from the intestines and other organs of affected pigs, as well as from conditions other than bowel œdema.

Campbell found that *Esch. coli* in pigs with œdema disease was found most consistently in rectums and colons, and rectal swabs were used as a basis for comparison with normal pigs. Specific serotypes of hæmolytic *Esch. coli* are found in œdema disease in Canada, and two are sufficiently well distributed in normal pigs (0138:K81 and 0141:Kx) so that it looks as though an additional factor was necessary in the pathogenesis of bowel œdema, to permit the proliferation of those types. Timoney describes the isolation and prophylactic use of two typesof sera, but he also found a non-specific toxic factor in supernatant bowel fluid from non-œdema disease carcases.

The disease affects young pigs when in the process of being fattened, and the usual age is round about from 10 to 18 weeks, although younger and older pigs have been found affected occasionally. Those ages are critical ones in the young pig's life, as by then it has left its mother's care and is generally confined in pens on a ration which is perhaps apt to be somewhat heavy for a pig of that age. One or two pigs may be affected in a pen, or it may be that the first indication of trouble is the finding of a dead pig. There is generally a history of movement of pigs, or a change of food which appears to be an exciting cause.

If no steps are taken to counter the condition the mortality rate soon mounts up. Lamont, Luke and Gordon, following on some serum-protein estimations in œdema litters, found a degree of hypoproteinæmia present, and they rightly drew attention to the bad housing of pigs in general, with lack of attention to warmth in particular.

Symptoms.—Pigs affected do not always refuse food in the early stages, but there is a noticeable œdema around the eyelids, and this may extend to the face, the ears, jowls, elbow and hock joints, and even along the belly of the pig. The coat becomes harsh and staring, and some inco-ordination of movement is

noticeable. Diarrhœa is not always a symptom, and affected pigs may even be constipated. The animal moves in circles, or finds great difficulty in adjusting its limb movements when disturbed. Paralysis sets in, and where the œdema spreads to the lungs, the symptoms are easily mistaken for those of virus pneumonia as far as respiratory movements are concerned. Death occurs in from 4 to 36 hours, although some of the stronger pigs linger on and even recover. When the disease is in an advanced stage and paralysis has set in mortality is high. The disease does not spread from pig to pig throughout the herd, but sporadically affects pigs in different litters.

Post mortem.—The characteristic œdema already mentioned in the eyelids, face and other regions, together with an impacted stomach, are the first lesions noticed. If the stomach wall is cut into there is an œdema between the walls, and this extends throughout the mesentery. The whitish-yellow fat of the mesentery is replaced by a clear œdematous fluid extending even along the colonic mesentery. Œdema of the lungs, the pericardial sac, the larynx, and some limb joints, and even of the meninges of the brain and spinal cord, have also been found. Animals slaughtered before this advanced stage is reached show little œdema in the carcase, but the cramming of the stomach with food and the œdema of the stomach wall are fairly constant post-mortem findings.

Treatment.—Various medicaments have been tried, but attention should immediately be given to the ration, by substituting a wet mash with some purgative such as sodium sulphate, the dose varying according to the size and age of the animals affected. From 6 to 12 drachms per pig well mixed in a wet mash feed has been found useful. Streptomycin may help in controlling *Esch. coli* infection. Injections of diuretics[1] have also been reported to be beneficial. For some days after care will have to be taken to bring the pigs back on a full fattening diet too soon; it should be a gradual process. As a long-term plan it is well to enquire into the husbandry of the dam. Sows that have been allowed a run on some luxuriant pasture with their little pigs seldom have progeny affected with this disease. A pig at 18 weeks of age is still in the young and tender stage, and the ration can be too "heavy" for pigs

[1] "Vetidrex"—Ciba.

starting off with a deficiency of some vital factor whether protein, vitamins or minerals.

Differential diagnosis.—The panting which follows œdema of the lungs causes this disease to be mistaken for virus pneumonia, but the puffy eyelids, and the fact that the pig is not usually emaciated, and has not the clear cough of the pneumonia pig, serves to distinguish œdema disease. Pneumonia at this age tends to be rather a chronic complaint with some apparent unthriftiness in the affected animal as compared with its fellows in the same pen. The cough in pneumonia is more distinct, and not so husky as it is when laryngeal œdema is present. In a straightforward attack of indigestion in the pig the animal is usually off its food, and a putty-coloured diarrhœa is present, whilst swine fever and swine paratyphoid show some redness of the ears, and scab formation on the "trotters" or other parts of the body. High temperature is not an usual feature of œdema disease.

Leptospiral Infection in Pigs (Stuttgart disease, swineherd's disease).—Recent work has shown that leptospiral jaundice of pigs due to *Leptospira icterohæmorrhagiæ* is a well-established entity to Britain especially in East Anglia and Scotland. In the United States, however, infection with *L. pomona* is the most common cause of leptospirosis in swine. Both conditions have nevertheless aroused considerable interest in view of infection to man, primarily to those engaged in agricultural pursuits which bring them into contact with pigs and piggeries. *L. icterohæmorrhagiæ*, which causes Weil's disease in man and similar conditions in dogs and cattle, is contracted from food and water supplies which have been contaminated by urine from rats harbouring the infection in their kidneys. Surveys have shown that a high proportion of brown rats (*Rattus norvegicus*) are carriers. In the case of *L. pomona* infection appears to take place more directly from carrier pigs. With both types of infection, adult carriers maintain a source of infection for young animals on the premises and for susceptible animals which may be added to the herd. *L. canicola* can survive in the naturally infected pig kidney for 12 days at refrigerator temperature, and these kidneys fed raw can infect dogs and cats.

Symptoms are usually seen in young pigs from sucking pig

stage to one or two months of age. *L. icterohæmorrhagiæ* affects a number of piglets at the same time and causes listlessness, inappetence and high fever which is followed in two to three days by jaundice. The latter is first seen at the base of the ears, inside the thighs and axillæ, but soon spreads to the whole body. Death usually supervenes although spontaneous recovery has been reported. Post-mortem appearance is that of a generalized jaundice with hæmorrhages into various parts of the body, especially in the intestines, kidneys and liver. *L. pomona* on the other hand appears to cause a comparatively mild disease which may not be recognized in a large herd. The affected pigs show various degrees of inappetence, fever and diarrhœa all of short duration. In rare cases hæmoglobinuria may be present. In the more chronic form no clinical signs may be seen, but localization of infection in kidneys can be demonstrated, the disease being self-limiting with complete elimination of Leptospira from the kidneys in six to nine months after initial infection. The chief loss from this infection is due to abortion or the birth of weak pigs which soon succumb. *L. pomona* has not yet been established as a clinical entity in Britain, but the risk remains of the introduction from European states. It was first isolated in Australia by Clayton (1937) from a person suffering from a condition which was called seven-day fever.

Diagnosis is usually confirmed by laboratory work in the form of serological tests, usually micro-agglutination. Cultural techniques may be applied to fresh material, but techniques are very specialized, Leptospira growing only in certain media under carefully controlled conditions. Staining methods involving silver impregnation can be used, but probably the most convenient method is the examination of fresh urine under dark field illumination. Leptospira may be seen with as little as 120 magnification. Hamsters and guinea pigs may be used to obtain the organism in pure culture. In America, rapid agglutination tests with stained antigen are available for field work.

Treatment. Infected pigs respond well to the parenteral administration of streptomycin with penicillin, provided treatment is commenced at an early stage. Oxytetracycline, tetracycline and erythrocycline are also reported as being effective, the first being reported as eliminating 94 per cent. of

renal carriers when given in food at the rate of 500-1,000 g. per ton (Baker, 1957). Rigid sanitary measures, including control of rats, must also be implemented. The serological test, which is valuable as an aid to diagnosis, has not yet been developed to the point where it can be applied with certainty to individual pigs for control purposes.

The symptoms described in pigs have usually been those of the encephalomyelitic diseases already mentioned.

Balantidium.—Of these ciliate parasites, *Balantidium coli* is said to have been found in the pig, but although the parasite has been held responsible for lesions of dysentery in man and monkeys, no harm appears to have been done to pigs by this parasite.

Toxoplasmosis.—This is caused by the parasite *Toxoplasma gondi*, isolated from the North African rodent, the Gondi. *Toxoplasma gondi* multiplies by longitudinal binary fission inside the host cell. When mature it is lemon shaped, $5\mu \times 1{\cdot}5$ to 2μ. It burrows into the reticulo-endothelial cells and divides repeatedly until from 8 to 15 daughter-cells are formed. When the host cell dies, the contents are dispersed by rupture of the cell membrane. The tightly packed parasites soon flourish on the intracellular fluids, and can then infect new cells. The parasite encysts when growth conditions are unfavourable and although it affects most warm-blooded animals as well as man, pigs of all ages may be infested, and healthy in-contacts can develop the disease.

Symptoms.—Pigs resistant to experimental infection can have the disease in a subclinical form. The condition is able to assume serious proportions in a herd, causing high temperatures, weakness, and collapse. Joint œdema is a complication.

Treatment.—A combination of sulphamezathine and Daraprim.[1] Cortisone is also an useful addition. The Daraprim is prescribed to prevent any relapse, with the possibility of a carrier stage being reached.

Trypanosomiasis.—Among trypanosomes found in pigs in tropical countries are *Trypanosoma brucei*, *T. congolense*, *T. vivax* and T. *simiæ*. Of these the latter is the one causing most serious trouble in pigs. The affected animals are found dying suddenly, symptoms being few. The pig may run a high tem-

[1] Pyrimethamine.

perature, with some dullness and loss of appetite. Trypanosomes are found swarming in the blood stream. Wilson reported *T. simiæ* to be highly pathogenic for pigs in Uganda, whilst others have reported similarly as regards other parts of Africa.

Various drugs have been reported as being effective when used against certain trypanosomes. Intramuscular injections of Surfen C (Bayer) and Antimosan have been used against *T. congolense* in cattle and horses. Experimentally Styryl 314 has been used against *T. brucei*, whilst other drugs are Phenanthridinium, Bayer 205, trypan blue, antimony and arsenical compounds. In the report mentioned above, Wilson used dimidium bromide in *T. simiæ* infections in pigs. Apparently this drug has only a limited effect on *T. simiæ*, as treated pigs tend to become chronic relapsing types. The pigs tolerate the drug in repeated doses very well, commencing with about 1 mg. per kg., or 2 mg. per kg. intramuscularly, repeated weekly.

Antrycide salts given subcutaneously in single doses have cured infections of *T. congolense*, *T. vivax* and *T. brucei* in cattle, *T. brucei* in horses and dogs, *T. evansi* in camels. Antrycide is also used on pigs.

The adoption of such preventive measures as cleaning up the fly belt areas of Africa is a process replete with difficulties. Measures are in operation constantly to try and destroy the fly carrying the trypanosome.

Trypanosoma melophagium.—This trypanosome is non-pathogenic and is believed to be the one found sometimes in British pigs.

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Chapter 8

DISEASE IN THE NEW-BORN AND YOUNG PIG

In all species of animals, the neonatal period provides by far the most serious hazards to the survival and development of individual members; the chief responsible factors comprise environment, nutrition, heredity and other biological considerations. In the pig, where methods of breeding, rearing and fattening are carried on to such a high degree of intensification, the influence of these and possibly other, undetermined, factors is most pronounced and a considerable rate of wastage is to be expected. That such a loss is commonly experienced is shown by the many surveys which have been carried out to assess the incidence of disease in young pigs. The pre-weaning mortality rate of 15 to 25 per cent. described by Longwill (1952) is supported by Goodwin (1955), who affirms that such losses occur wherever pigs are reared. The pigman is familar with the almost daily loss of piglets where a number of sows and gilts are farrowing, while the veterinary surgeon is often confronted by the clinical picture of mass over-laying by sows, with the resulting massacre of scores of baby pigs. This may occur on a large scale over quite a short period of time, but in many cases the farmer regards the phenomenon as accidental or due to a state of particular clumsiness or viciousness on the part of the dam. Although it is not to be denied that the occasional accident must occur in view of the large numbers of tiny animals which comprise the average litter, few stockmen are prepared to admit that these losses may be due in the first place to subnormal piglets which are too weak to keep themselves clear of the looming bulk of the sow. This weakness, be it physical as regards muscle action, or constitutional as regards resistance to infection, is related usually to the pregnancy period and may, indeed, refer to an even earlier period in the life history of the mother. The causes of death in these circumstances are known colloquially as chills, scour, colds or over-laying. Whatever

appellation is applied to the so-called cause of death, it should be remembered that it is much more likely to be effect rather than cause.

Hypoglycæmia.—This condition is also called "Baby pig disease" and refers to the syndrome brought about by a reduction in blood sugar concentration. In the normal piglet, as nutrition gathers momentum after birth, the blood sugar level increases steadily over the following few days. Although the glycogen reserve is initially high, the piglet requires a constant supply of sugar to sustain its metabolism, and should the milk intake be reduced temporarily, or interrupted entirely during the critical first five or six days, the consequent rapid ebbing of the blood sugar concentration produces the symptoms of so-called "baby pig disease." Complete starvation causes a profound state of hypoglycæmia in which death follows rapidly, but more commonly there is a progressiv ereduction of milk consumption and the signs of disease are less marked and delayed. This hypothesis was established by Graham, Sampson and Hester (1942), who produced an identical syndrome by the experimental starving of piglets. Confirmation was offered by Goodwin (1955), who recorded similar results, and the influence of post-natal age and environmental temperature in determining the speed at which the condition develops was discussed by Hanawalt and Sampson (1947) and Morrill (1952) respectively. It should be remembered, however, that the well-defined clinical syndrome produced by this fall in blood sugar may be due not only to primary factors such as starvation or reduced milk intake, but also, secondarily, to many specific infections and other diseases. These, superimposed upon the piglet during the period of extreme instability of carbohydrate metabolism, produce a fatal hypoglycæmia before the symptoms of the primary condition can become manifest.

The secondary conditions are classified by Goodwin (1955) in two groups, viz. those originating in the piglet, *e.g.* bacterial conditions including streptococcal, coliform, erysipelothrix and clostridial infections, certain virus diseases and other syndromes such as hæmolytic jaundice, myoclonia congenita, injuries and deformities, and those originating in the sow, including physical factors such as insufficient or blind teats, temperament, agalactia or dysgalactia and specific infections. Jarrett, McIntyre

and Thorpe have found *E. monocytogenes* infection in piglets in Britain, with necrotic foci in the livers. Absence or poor supply of milk in the sow is in itself usually secondary to general infections, mastitis, metritis or hormonal failure. All the conditions mentioned do not comprise a fully comprehensive list but include the commonest encountered in practice.

Symptoms.—A characteristic clinical picture is seen in the piglet affected by simple hypoglycæmia. For the first twelve hours or so it appears normally active and enthusiastic in its search for food. It grunts and scampers and feels warm to the touch, the unpigmented breeds being bright pink in colour. This is no deviation from the normal, but as the blood sugar level falls the metabolism appears to slow down in direct proportion to the sugar reduction. The piglet is at first very noisy and becomes less active. An early feature is the appearance of locomotor uncertainty which soon progresses to a state of incoordination with regular convulsive movements of the limbs. Air-hunger causes champing of the lower jaw against the upper and whips the saliva into a froth. As the condition proceeds over the next few hours, the declining metabolism is marked by fall in body temperature, reduction in heart rate, pallor of the skin and cyanosis of the extremities. The end-point of coma followed by death is reached in periods which vary, according to the primary factors, between 24 and 48 hours. These limits may be exceed by hyperacute cases developing more quickly or, more commonly, by protracted cases which are related to partial reduction in milk supply. In these latter cases, dehydration and renal failure provide additional obstacles to successful treatment. To the signs of hypoglycæmia must be added those of any specific condition which may be primarily responsible. Such variable features, however, are rarely present in a distinctive form and will be differentiated clinically with difficulty. In these cases, the use of laboratory aids to diagnosis is essential. Post-mortem examination reveals no obvious abnormality except for the absence of milk curd in the stomach and intestines where agalactia has been present and the piglet has suffered starvation from birth.

Treatment.—The uncomplicated hypoglycæmia syndrome responds spectacularly to the repeated administration of readily assimilable sugar solutions if treatment is applied before any

marked depression of the nervous system develops, and provided there are no superimposed conditions which are masked by the hypoglycæmia they produce. Ten to twenty ml. of a 40 per cent. solution of Dextrose in normal saline are injected subcutaneously or intraperitoneally, the usual antiseptic precautions being observed. Response is rapid, but in view of the speed of sugar utilization the dose should be repeated at 4- to 12-hourly intervals depending on severity of symptoms. To reduce the rate at which the body sugar is metabolized, it is essential to keep the piglets as warm as possible. The observations of Morrill (1952) in this respect substantiate the value of artificial heating, which is provided by infra-red lamps as standard practice in good husbandry. The problem of maternal agalactia should be investigated and hand-feeding implemented if it proves impossible to obtain a satisfactory milk supply from the sow. If an underlying disease is present, the specific therapy in that case must also be applied, but it cannot be expected that recovery will occur even if the secondary hypoglycæmia is temporarily overcome.

Prevention.—By far the most satisfactory approach to prevention of this disease is in the antenatal care and feeding of the sow or gilt. The stockman must practise good husbandry even before the animal is put to the boar and throughout the gestation period adequate food, water and exercise must be provided. The running of sows and gilts out-of-doors on pasture is excellent, but supplementary feeding and watering is too often neglected. The value of good stockmanship during the period of parturition cannot be over-emphasized.

Hæmolytic Disease of the New-born Piglet.—Although this condition has existed as a recognizable clinical entity for some years, few references have appeared in veterinary literature to indicate that thorough investigations have been carried out. The disease is characterized by hæmolysis of red blood cells following the pattern of events which is well known in the human subject and other species, when a rhesus-+ male is mated with a rhesus-— female. The inheritance of the rh+ antigen from the father provokes antibody production in the mother. This antibody may pass back into the fœtus causing death *in utero* or abortion, or may be concentrated in the milk. The fœtus is then born normally but receives the antibody in large doses

as soon as it starts suckling, and as the factors concerned are closely associated with red blood cells, destruction of these follows rapidly. The classical appearance of jaundice is merely a clinical sign of this hæmolysis. Bruner *et al.* (1949) have described the artificial production of this syndrome by the immunization of a gilt against the red blood cells of a boar the blood of which was incompatible with that of the dam, and Kershaw (1950) suggested this hypothesis as the important factor in a number of cases of hæmolytic disease in piglets. Buxton and Brookshank (1953) carried out a wider investigation and substantiated their report with hæmatological and serological confirmation. Despite recent work by Goodwin and others (1955), a good deal remains to be done to clarify the position regarding blood groups of pigs before the hæmolytic disease picture can be properly understood.

The injection of crystal violet, swine fever vaccine, which is prepared from the blood of pigs, has been shown by Goodwin (1955) to be capable of producing red cell iso-antibodies. The high titres reached may be responsible for hæmolytic diseases production in sows as the result of blood group incompatibility. The replacement, however, of the porcine vaccine by one adapted to eggs or rabbits would remove this hazard.

A method of clinically diagnosing hæmolytic disease in the new-born pig has been suggested by Goodwin. The colour of the little pig varies from icteric to pink-red subcutaneously, with a full stomach and hæmoglobinuria. A few drops of free-flowing blood placed at one end of a slide is tipped gently back and forth to wash the cells in their own plasma, and then allowed to sediment. As much blood should be used as is possible without spilling. In a positive case the blood is usually very thin. When the blood is allowed to dry out the plasma, in positive cases, is often tinged with yellow, and the erythrocytes tend to aggregate into discrete clumps, according to the severity of the disease.

Symptoms.—The piglets are born normally and remain healthy for a period lasting about 24 hours. As a rule, the condition is not associated with still-born piglets. By the second day, it is usually possible to detect slight changes in the colour of the skin and visible mucous membranes and the piglet exhibits varying degrees of weakness. The skin may be

pallid when anæmia alone is present and develops a deepening shade of yellow as icterus advances. In some cases a dark brown colour is attained before death from toxæmia occurs. The rate at which the symptoms develop depends on the speed and degree of hæmolysis, but by the fifth day most of the litter have gone and there are usually few survivors by the time the condition has run its full course.

Post mortem.—A jaundiced condition of the intestines is a fairly constant feature even in cases which do not show obvious icterus of the skin. The presence of blood-stained peritoneal fluid and dark-coloured urine, which may resemble port wine in appearance, provides other important features. The liver, spleen and kidneys are congested and enlarged and icterus of the skin, serous and mucous membranes, musculature and brain is present in varying degree. The presence of bile pigments may be confirmed by the application of simple biochemical tests in those cases where colour is insufficiently definite to the eye. In black piglets, the skin along the belly and in the groin, and the musculature, are best examined for icterus.

Treatment.—Unless some elaborate technique such as exchange transfusion is practised, a procedure which is impracticable in the field and in the absence of information on blood groups in pigs, therapy is unlikely to have any direct effect on the diseased piglet. The latter, with its litter mates, must be removed immediately from the dam and provided with artificial feeding. They must be kept as warm and as quiet as possible in order to conserve body sugar and to reduce the strain on the depleted circulatory system. The use of blood volume expanders such as dextran solution containing sugar would be of considerable value to the affected pigs. Injection of preparations of this type are readily made with a comparatively fine bore needle directly into the anterior vena cava. If the condition is treated early and hæmolysis has not reached a serious degree, some success may be attained by therapy along these lines.

Eperythrozoonosis.—Ictero-anæmia. There is evidence that this condition is a far from new disease and is now well recognized as a clinical entity in America. Recently, workers at the Cambridge School of Veterinary Science have demonstrated the causal organism in cases of anæmia of pigs in Britain and further

work will no doubt reveal the extent of the condition amongst British pigs. McNutt (1943) concluded that the viruses he was investigating at the time were not the cause of anæmia in the pigs he observed, and others, including Doyle (1945), observed bodies in blood films from affected pigs that resembled anaplasma. Splitter (1950 and 1950a) and his colleague, Williamson, showed that a blood parasite, Eperythrozoon, was responsible for at least one type of anæmia associated with jaundice, and the work at the Kansas State College demonstrated that there are at least two such parasites which affect pigs, *Eperythrozoon suis* and *E. parvum*. The former, which is the larger, is distinctly pathogenic and produces extensive destruction of red blood cells. Splitter described the parasite as a small, ring-shaped body found on the surface of the erythrocyte and occasionally free in the plasma. It stains well with Giemsa or Wright's stain if this is intense. Up to 80 per cent. of cells may be affected and enough parasites may be found on a single cell to cover its entire surface. The workers at the Kansas State College found a high incidence of infection during the summer, while winter-born pigs were observed to be comparatively free. This observation may suggest the presence of an insect vector during the warm weather. While young pigs exhibit an acute and often fatal form of anæmia, pigs of all ages appear to be susceptible and carrier formation for an indefinite period appears to result. Experimental work has shown that the incubation period is 6-10 days and an initial temperature rise heralds the onset of symptoms.

Symptoms.—The affected pigs are depressed, inappetence being marked. After a day or two, a severe anæmia becomes apparent, the pigs becoming weak, unable to stand, cold, with subnormal temperatures, and showing in the later stages a varying degree of jaundice. Death rapidly supervenes. Most pigs in a herd are probably infected and a number may show at least the initial temperature rise, but only a comparatively small percentage develop further clinical signs.

Post mortem.—The lesions are very uniform and striking in appearance. The blood becomes very thin and watery in consistency, and contains bile pigments. The spleen is much enlarged and icteric fluid is found in most body cavities. A severe hepatitis is present in which necrosis and hæmorrhage

in the central portions of the liver lobules are apparent. The musculature and serous and mucous membranes of the body may also show jaundice.

Treatment.—Splitter (1950b) found that arsenical preparations in the form of neoarsphenamine at the rate of 45 mg. per kilogram body weight, given by intravenous injection, were effective in reducing the numbers of blood parasites and preventing further destruction of erythrocytes. The marked anæmia demands the consideration of blood transfusion technique or the use of an artificial blood-volume expander such as dextran solution. Very young pigs will need glucose to combat the development of a state of hypoglycæmia and all affected animals should be kept as warm as possible.

Congenital Porphyria in Pigs.—This rare disease is described by Jorgensen as occurring in pigs in Denmark. It is a condition where the teeth and bones are discoloured, and is believed to be transmitted through an affected boar. The small amounts of porphyrins excreted normally are by-products of the hæmoglobin (protoporphyrin) synthesis and not of hæmoglobin disintegration. The porphyrias are said to be due to anomalies in the enzymatic systems governing the transformation of porphobilinogen into protoporphyrin. Jorgensen finds that the condition can be transmitted through both males and females. The condition is hereditary and depends on one or more dominant genes, as opposed to the condition in cattle which depends on a recessive gene. The teeth and bones may be dark brown in colour, and in new-born pigs this makes the diagnosis possible. Light sensitivity of the skin has not been observed in pigs.

Enzootic Paresis of Pigs.—This virus disease has been described as occurring in pigs in Denmark. It is a condition in which characteristic histological changes are found in the central nervous system, and it has been possible to reproduce the disease in little pigs by inoculation of suspension of CNS tissue from affected animals. The disease has been referred to as Enzootic (transmissible) Pig Paralysis (poliomyelitis suum). The changes in the nervous system are somewhat similar to those found in Teschen disease, but in the latter the changes are more extensive. Teschen disease is also clinically much more severe, with fatal ending, whilst enzootic

paresis is of a more benign nature, according to Aage Thordal-Christensen.

Symptoms.—A number of pigs in the same herd are affected simultaneously. Initially there is diminished control of the hind legs, slight ataxia of the hindquarters, and a weakened hollow back. Temperature is elevated. Left alone pigs lie down and tend to hide in the bedding. Appetite decreased, with difficulty in competing for food at the trough owing to the inco-ordination of movement. The condition either resolved itself or passed on to a stage of paralysis of the hind legs, and even of the fore legs. In the early paretic stage pigs lay with fore legs bent and hind legs stretched out sideways or backwards. Small pigs severely affected lay on one side and were unable to turn over, becoming excited on trying. Between the excitable periods were stages of muscular tremors and jerky contractions of the leg and trunk muscles. Respiratory muscles generally remained normal. Some sucking pigs showed swollen abdomens from paralysis of the urinary bladder and retention of urine. Recovery was slower in older pigs, but left no apparent muscular atrophy.

Post mortem.—Musculature and organs normal, except where paralysis of the bladder had occurred. In little pigs with severe symptoms, there was some œdematous condition of the brain and fluid under the cranial and spinal membranes. Histological changes of varying degrees, amounting to perivascular infiltrations of mainly mononuclear cells, were present in the grey matter, especially in the ventral horns. The large motor nerve cells were only slightly degenerated or were normal. There is some slight perivascular infiltration of mononuclear cells in the white matter.

Differential diagnosis: Symptoms similar to those described by Thordal-Christensen occur in other pig diseases involving encephalitis. Glasser's disease is one, but here several pigs in one herd may be affected without spreading throughout the lot. There are also local inflammatory lesions in the joints of the limbs, and the bacterium responsible is hæmolytic. There is a beri-beri like disease of pigs in Denmark, where the animals are on a high carbohydrate diet, but here there is also marked circulatory disturbances with dyspnœa and other signs. In bowel œdema, the dropsy is a marked characteristic, and the

disease carries a high mortality rate. The disease nearest to this benign paresis is Teschen disease, also caused by a virus, and where there is in addition pronounced excitability with convulsions. The cranial nerves are often affected in Teschen disease, and again the mortality is high.

Talfan Disease.—This is reported by Harding, Done and Kershaw to be a transmissible polio-encephalomyelitis of young pigs. It is non-suppurative and although it bears some resemblance to Teschen disease, it can be differentiated from the other nervous diseases recognized in Britain. The causative agent is thought to be a virus. It is widespread in distribution and although usually mild in its effects it does show a variable manifestation as an acute fatal disease in young piglets, a subacute paralytic condition, or a chronic ataxia.

Symptoms. These develop usually in 3-6 week old piglets, *i.e.* during the suckling and immediately post-weaning period. Morbidity is low after an incubation period which appears to be twelve or more days in field outbreaks. Some initial fever may be found, but by the time nervous symptoms are noted the piglets are usually eating and temperature is normal. The nervous signs include cerebellar ataxia which is seen as a "swayback" type of paresis or paralysis; rare cerebral signs may show as fits. The acute type progresses rapidly with death of the patient in about 48 hours. Other cases may show a slow recovery with residual ataxia or muscle contracture.

Diagnosis.—This is confirmed mainly by the demonstration of specific lesions in the various parts of the brain. These take the form of vascular cuffing and microglial stimulation which should be present in the medulla, mid-brain and cerebrum. The cerebellum and spinal cord rarely show these microscopic changes. Pigs which have been ill for at least 10 days or have died from the disease are likely to show the best defined lesions. There is no specific treatment but careful nursing and provision of suitable food will aid the recovery of some cases if it is considered an economic procedure.

Diseases affecting the Blood.—Changes occur in the blood whenever there is any disease in the blood-forming tissues, such as the bone marrow and lymphoid tissues of the body. Normally the erythrocytes or red blood corpuscles are said to number approximately 6 to 10 million per cubic millimetre,

but their size and number vary in different animals. A temporary increase in their number (*polycythæmia*) may occur following diarrhœa or excessive perspiration—*i.e.* where there is some withdrawal of fluid from the body. A decrease in number, or *oligocythæmia*, occurs in some anæmias and toxæmias. *Anisocytosis*, or a variation in the size of the erythrocytes, may also be found in anæmia. Corpuscles which are smaller in size than normal are called *microcytes*, and large

FIG. 66—A FORM OF SPASTIC PARALYSIS IN A LITTER OF NEW-BORN CROSS-BRED LANDRACE PIGS. THE "CRAB-LIKE" POSTURE WAS CHARACTERISTIC

corpuscles are called *megalocytes*. Giant corpuscles are known as *gigantocytes*, whilst the normal capsule is often called a *normocyte*. Microcytes are often found in anæmia, and so are *poikilocytes* or irregular-shaped corpuscles. As a rule the red corpuscles of pigs, as of the other domestic animals, are non-nucleated, but nucleated forms or *erythroblasts* are found in the bone marrow, passing into the blood circulation after their nuclei have vanished. When there is some increased demand for red blood corpuscles these erythroblasts may be passed

into the blood, and may appear as *normoblasts*, *megaloblasts* or *microblasts*, according to their size. *Reticulated cells* are young cells which have only just lost their nuclei. These may be demonstrated by staining the blood fresh, without drying or fixing. When stained by Romanowsky's stain some cells may show a blue tint (polychromasia or basophilia), and in punctate basophilia the cells show purple-stained granules. This condition is said to be characteristic of chronic lead poisoning, and of some toxic conditions leading to anæmia.

The hæmoglobin content of the blood varies considerably in anæmic conditions. When there is a deficiency of hæmoglobin the pale centre of the corpuscle is very pronounced, the colour being present as a ring round the periphery of the corpuscle. A decrease in the hæmoglobin percentage does not necessarily mean a decrease in the number of corpuscles. The *colour index* denotes the hæmoglobin content of each erythrocyte. In certain forms of anæmia the numbers of erythrocytes may be reduced, but they may still have a high hæmoglobin content. During or after hæmorrhage the red cells of the blood have a normal hæmoglobin content. The colour index consists, therefore, of the percentage of hæmoglobin in the blood divided by the percentage of red cells in the blood. In a normal animal, if the percentage of hæmoglobin is 100 and that of red cells is 100, the colour index is 1.

The leucocytes, or white cells of the blood, are nucleated and are not so numerous as the red cells, and in the pig they are said to average about 20,000 per cubic millimetre. In *leucocytosis* there is an increase in the number of white cells, especially of the neutrophils or polymorphonuclear leucocytes, which account for about 50 per cent. of the white cells normally found in pig's blood. Inflammatory conditions and hæmorrhage may produce this leucocytosis. In *lymphocytosis*, which occurs in rickets, there is an increase in the number of lymphocytes, whilst monocytes are increased in number in *monocytosis*, which occurs in certain infectious diseases. Certain parasitic conditions and some chronic skin diseases are said to give rise to an increase in the eosinophile leucocytes (*eosinophilia*). Malnutrition and starvation, as well as certain diseases, may produce a decrease in the number of leucocytes.

a *leucopenia.* As in the case of the red cells, certain primitive types of leucocytes may be found in the blood circulation when there is a great demand for blood in the body, as when disease processes interfere with the formation tissues such as the bone marrow.

Anæmia.—Pig anæmia, or nutritional anæmia, may be termed a secondary anæmia resulting from a poverty or deficiency of certain substances, notably iron, in the food. Iron is stored in the animal's body largely in the hæmoglobin of the red blood cells; there is also a trace of tissue iron and some reserve in the liver, spleen and kidneys. The iron present in these last organs, the spleen and kidneys, is said to depend on the rate of destruction of the erythrocytes. The amount of iron in the liver, on the other hand, depends upon both the iron taken into the body and upon the rate of red blood cell destruction. Feeding iron is said to increase the liver reserve. Pigs have some reserve of iron in the liver at birth, although the hæmoglobin level is not as high as in some other animals.

The percentage of the body iron is diminished during the time the young animal is fed exclusively on its mother's milk, and the total hæmoglobin is increased. When the young animal commences breathing through the lungs at birth there is then a surplus of hæmoglobin, and some destruction of the erythrocytes takes place; this is said to be in the nature of a replacement of the fœtal erythrocytes by cells of a different type, and the iron so liberated is stored in the liver. This iron is later used up during rapid growth, when new cell formation is required to keep pace with the growth of the animal. If the liver iron is inadequate and that derived from the food insufficient, anæmia is likely to follow, and it will probably be the fastest growing that will be affected first.

The presence of a normal reserve of iron in the young animal's body at birth depends upon the mother having had a sufficient supply in her diet, but it has been found that adding an iron supply to the nursing sow's ration will not cure anæmia in the little pigs, unless they, too, get a supply of iron. It has been found that for the first three weeks of the pig's life an intake of 7 mg. of iron per day is required to keep up the growth rate and total iron level. The little pigs cannot

obtain sufficient iron from the sow's milk, so that free access to soil and pasture is vital.

In some cases anæmia has been attributed to a deficiency of copper in the ration. In such cases feeding with iron does not cure the condition, but the addition of copper in the form of the sulphate cures the anæmia, even when it is given without iron. Other minerals such as magnesium and calcium, etc., have also been suspected of being implicated in the causation of anæmia, but there is some doubt as to whether a deficiency of such substances is a cause.

Vitamin deficiency has also been blamed, but vitamin A has been ruled out as a cause of anæmia. There is an anæmia in pellagra, but there does not appear to be any direct relationship between an absence of vitamin B_2 and the anæmia in question. There does appear, however, to be some relationship between vitamin C and blood formation, and it is believed that absence of this vitamin from the diet may lead to anæmia in some animals.

The action of the endocrine glands is believed to be of a general nature, and not due to their being in any way specific causes of anæmia, as are iron and copper.

Symptoms.—These may appear when the little pigs are about three weeks old, when the animals appear dull and listless. The skin has a pallid appearance, and in some instances the bristles are inclined to be curly, giving the pig a much more "hairy" appearance than is usual in that age. The backs may be arched, and there is a generally unthrifty look about the piglets, with evidence of diarrhœa or even scour. In the early stages an excessive pallidness of the skin combined with a lack of activity may be the only visible symptoms.

Post mortem.—A general paleness of the skin, the flesh, and liver is found as a rule, but it sometimes happens that the liver retains its colour. There is usually an excess of fluid in the peritoneal, pleural and pericardial cavities, with an œdema of the bowl, stomach wall, the throat, and even the eyelids. This œdema of the bowel is not confined to piglets affected with anæmia, but appears to be a lesion found in many diseases due to dietetic origin, and indeed some people even tend to regard "œdema of the bowel" in pigs as a specific disease

especially of the recently weaned. The blood is usually very watery, and clotting is delayed. In pigs from eight to twelve weeks the stomach will often be found distended with undigested food of a fibrous nature, whilst the intestine is empty or contains only a bright yellow mucoid slime. Such pigs are usually very pot-bellied in appearance, and rough in their coats.

Treatment.—The addition of purified iron salts to the ration will not be of much use unless copper is added. If after

FIG. 67.—PROLAPSED RECTUM IN A PIG AFFECTED WITH SEVERE ANÆMIA AND DIARRHŒA

feeding iron for some time copper is added, the iron stored up in the liver is then used for the formation of hæmoglobin. Copper seems to be essential as a catalytic agent in this respect. It helps to use up the iron in the body, reducing the iron in the tissues and liver, and increasing it in the blood. At birth the copper content of the body is less than that of the fœtus, but it is said to be twice that of the adult. In anæmia a fall in the hæmoglobin takes place about the tenth day after birth, and it may fall to one-fifth its initial value

ess extra iron is fed. Where some extra iron is given, re is little fall in the hæmoglobin below that pertaining the tenth day. Iron salts are absorbed as *ferrous* salts l not ferric, and it has been found best to give some iron :, such as commercial ferrous sulphate, which contains ces of copper as an adulterant, or, better still, to combine per treatment with the iron treatment, the proportions ommended by continental authorities being 25 mg. of iron h 5 mg. copper daily. The iron-copper treatment is best ie by individual dosing rather than by giving in the food. nting the sow's udder with a mixture containing iron, per and treacle is also done, but is apt to cause the udder get into a sticky mess and collect dirt. A special doser y be purchased for dosing pigs, and if time and circumstances ow, treatment of every individual pig is always better in the g run.

Modern treatment is to inject iron dextran solutions hypo-rmically or intramuscularly, and piglets can thus be given ficient iron to last them over the weaning period.

It is no use treating the pigs unless the food is also attended A balanced ration should be provided for pigs old enough feed themselves, and the young pigs should have early cess to a supply of iron by allowing them a run at grass, and rowing in huts with access to a run in a grass compound the sow and litter. It is a good plan to place soil in the ns, and to provide iron-rich foods for the sow prior to rowing, so as to assist in the prevention of anæmia in the ung when born. The iron treatment of the little pigs ould be carried on until they are able to fend for themselves, ıen the ration should contain a sufficiency of these anæmia-eventing substances.

The following prescription may be used for a mixture of on and copper to be painted on the sow's udder: Anhydrous rrous sulphate 3½ oz., copper sulphate ¾ oz., manganese 1 oz., ater 1 pint and treacle 1 pint, well mixed and painted on e teats and udder of the sow. For individual dosing a lution may be prepared consisting of commercial ferrous lphate 1½ oz., copper sulphate 1½ drachms, water 2 pints, e dose being 1 teaspoonful per pig per day. In view of the le played by the vitamins in the assimilation of various

nerals, it may be advisable to administer some vitamin A d D. These are now available in capsules in a sufficiently gh concentration, so that one dosing is said to be enough to st the little pig throughout its short life. The best results e obtained when the iron and copper together with vitamins e given in a palatable form, or else in the form of subcutaneous intramuscular injections. Failure of the iron treatment is ten due to the unpalatable inorganic form in which the inerals are given to the pigs. It is always best to experiment ith other minerals besides iron and copper, as calcium, cobalt nd magnesium are often deficient in these so-called anæmias n pigs. Calcium in the form of calcium borogluconate crystals nay be given in the ration at the rate of a few crystals per pig per feed daily.

Transmissible Gastro-enteritis of Piglets.—This condition of baby pigs was first described by Doyle and Hutchings (1946) in America, and although mentioned by Goodwin of Cambridge (1955), it has not been recognized as a clinical entity affecting British pigs. It is possible, however, that the infective agent, which is probably a virus, does exist in Britain at the present time. It is essentially a disease of very young suckling pigs and is characterized by diarrhœa, occasional vomiting, rapid dehydration and a high death rate. Hypoglycæmia supervenes to enhance the severity of the symptoms. Older pigs may also be affected to a milder degree and appear to develop an immunity following recovery. This assists in self-elimination particularly in small herds, where control measures are usually more effective. A passive immunity which may be passed to piglets via the colostrum of the dam may protect them for several weeks, after which they may become susceptible. The disease is therefore seen in three groups of animals, viz the recently born and susceptible piglet which suffers severely, the 4-6 week old suckling pig which has lost its passive immunity but is better able to cope with the infection and shows little more than a whitish catarrhal diarrhœa of a few days' duration, and the store and adult pigs which may show no signs of infection at all but may act as carriers for a time.

Symptoms.—The disease commonly starts in one litter, possibly through the introduction of an affected pig on to the farm, and subsequently spreads from litter to successive litter.

The diarrhœa and vomiting are marked and death rapidly supervenes. The material passed from the anus does not, however, suggest a gross inflammatory process in the intestinal tract, a catarrhal enteritis being commonly present without any involvement of the gastric mucosa. It is possible that the severe signs of disease and death of the affected piglets are due entirely in the later stages to hypoglycæmia. In the older pig, the symptoms are milder, taking the form of a catarrhal enteritis with discharge of whitish diarrhœa material containing a good deal of mucus. Such animals stand a good chance of recovery, particularly as appetite is not affected to any great extent. A check, however, in the growth rate may cause an economic loss to the farmer.

Post mortem.—There is a distinctly pinkish skin colour in some cases, and some dehydration of the carcase in piglets, if the diarrhœa has been severe. Stomach lesions vary from some petechial hæmorrhages in the pyloric region to acute inflammation and ulceration. The intestine shows hæmorrhagic enteritis with inflation of the jejunum. The kidneys have subcapsular petechial hæmorrhages, or else they are paler than normal and contain urates. The cerebellar blood vessels may be blood congested, with evidence of some encephalitis.

Treatment.—While no drugs exist at present which have any known effect on the specific causal agent, the damage done to the baby piglet is so mild that prompt treatment of the supervening state of hypoglycæmia may assist effectively in reducing the loss from death of affected piglets. (See Hypoglycæmia or Baby Pig Disease.) General nursing procedures must be applied to all ailing animals, and in view of the infectivity of the causal agent strict isolation and disinfection measures must be adopted to control the spread. The presence of mild digestive disorders may be the only indication of infection in the adult animal and special attention should be paid to such animals, particularly when they farrow.

Joint Ill or Navel Ill.—This is a disease of piglets caused by infection of the umbilicus with pyogenic organisms and also by *Escherichia coli.* The disease is known by other names, such as polyarthritis, infectious enterohepatitis, pyosepticæmia neonatorum and septic omphalophlebitis. As in other species, predisposing factors play an important part in the initiation of the

disease. Wet, cold pens, lack of colostrum and other examples of mismanagement predispose to infection, which is most pathogenic if it occurs at the time of birth via the umbilicus or through infected milk from sows affected with mastitis or post-parturient fever due to *Esch. coli*.

Symptoms.—Very young piglets develop a yellowish-white diarrhœa with a fœtid odour. They lose weight very rapidly, weaken and fail to feed properly. Hypoglycæmia may supervene with death of the piglet. In older piglets abscess formation at the navel region may be the only noticeable symptom. Occasionally the infection spreads internally in the form of a pyæmia and there may be some noticeable swelling of the limb joints with abscess formation. The animal has a tucked-up belly, curved spine and is unthrifty and of bad conformation generally with a harsh staring coat, tail and ears drooping. Scour may be a prominent symptom and there will be some jaundice and an unsteady gait.

Post mortem.—Abscess formation can be found at the navel, in the liver, and the elbow and stifle joints may be swollen and contain pus. There may be some evidence of septicæmia, with some gastro-enteritis, hypertrophy of the liver and jaundice. The umbilical vessels will be corded with no suppuration visible.

Treatment.—If numbers of young pigs are affected, oral dosing of drugs is generally impracticable because of the number of treatments necessary and the difficulty of getting accurate amounts into the piglet. According to Schipper *et al.* (1956) parenteral dosing of the sow with one gramme doses of oxytetracycline (Terramycin) will ensure effective therapeutic levels in the milk. This method is only applicable, however, where the piglets are suckling. In other cases individual treatment with oxytetracycline or sulphadimidine has given good results if applied early in the course of the disease. The abscesses at the navel must be treated surgically and the affected piglets nursed in clean surroundings Measures adopted at farrowing time to ensure cleanliness of the umbilicus will assist materially in preventing the condition.

Glasser's Disease.—This should not be associated with the infection of very young piglets via the navel which has been described under the heading of navel-ill or joint-ill. This infectious serositis and arthritis was first described by Glasser

in 1910, but so far the true ætiological agent has not been elaborated. While it was generally assumed to be due to *Hæmophilus influenzæ suis*, recent work in America has linked the condition with a pleuropneumonia-like organism.

Symptoms occur in young pigs of 4 to 14 weeks of age and take the form of a fibrinous inflammation of the serous membranes of the limb joints, especially the hock or the knee or both. The piglet's temperature is raised and lesions associated with the pleura, peritoneum and pericardium have been described by workers in Europe and the United States. The affected pig is very lame and reacts strongly to handling or stimulus to move. The disease has a high mortality, after a short course, unless treatment is applied in the initial stages.

Treatment is likely to produce spectacular results if administered as soon as lameness and fever are noted. A single injection of penicillin may cure the patient in 24 hours. Cases seen later are much less satisfactory in response. Sulphadimidine or sulphapyridine added to the feed of pigs during the most susceptible period of three to eight weeks in small occasional doses appears to assist materially in the prevention of the disease on heavily infected premises.

Enterotoxæmia in Piglets.—This condition, due to *Clostridium perfringens Type C*, has been described by Field and Gibson (1955) and its experimental reproduction by Field and Goodwin (1959). Outbreaks of acute disease in piglets during the first 72 hours of life have been found to be due to infection with this organism which was isolated from the intestinal tract of affected piglets. It is suggested that sows may become carriers especially when kept on land during pregnancy and that the piglets ingest the organisms when suckling commences. Death follows bacterial multiplication and toxin production in the small intestine, particularly the jejunum. A short field trial with a serum containing *C. perfringens* beta antitoxin gave useful results as a prophylactic measure, but it is extremely unlikely that therapy will be able to arrest such a toxic process once it has commenced in a young piglet. An acute enterotoxæmia of older pigs in the 12 to 14 week old store class and due to *C. perfringens Type C* may sometimes be seen as a sporadic disease especially in pigs being given very liberal rations. The intestinal tract in these cases of sudden illness and death

shows a very acute enteritis with hæmorrhages under the mucosa. Rapid invasion and putrefaction of the associated alimentary wall follows and if examination is delayed rapid decomposition of the whole pig very soon makes itself obvious.

A condition described by Emsbo in 1951 and Field *et al.* in 1953 under the name of Terminal or Regional Ileitis is characterized by thickening of the ileum to resemble a rigid rubber garden hose and affects piglets from early life. In many cases no sign may be seen throughout the pig's life, but in some instances ulceration and perforation of the ileum leads to death of the pig through acute peritonitis usually in the 2-4 month period. The condition is differentiated from enterotoxæmia by the diffuse fœtid peritonitis and thickness and rigidity of the terminal part of the ileum.

Streptococcal Meningitis.—According to Field, Buntain and Done (1954) this disease, which is fairly widespread, has probably been imported into Britain from the Continent of Europe. It is characterized by ataxia with partial or complete loss of balance due to meningo-encephalitis, though nervous signs are not always present. Some cases recover spontaneously, some die during the bacteræmic stage and others remain chronically affected with arthritis. The cause appears to be a beta-hæmolytic streptococcus.

Symptoms are usually seen in pigs of 2 to 6 weeks of age, either as a sporadic condition or taking an epidemic form affecting successive litters of pigs. The affected pigs run a temperature, refuse food and bury themselves in straw. When forced to move one or more show a swaying movement with a stiff-legged gait which Field *et al.* suggest resembles the picture of a pig walking on its toes. The ears are retracted and held close to the head Vision is affected and tremors may shake the body especially after exercise Some pigs die in this febrile stage. Others lose balance and lie on their sides making paddling movements with their limbs. Less affected animals show only a slight swaying motion on walking and mild cases recover spontaneously. Protracted cases develop swelling over stifle and around hock joints and are obviously unthrifty.

Diagnosis is based on the history and symptoms and post-mortem lesions the most important of which is the turbid or creamy nature of the cerebrospinal fluid. This may be ex-

tracted from the cisterna magnum and will be found to be under considerable pressure. The subarachnoid space contains a whitish pus and the blood vessels of the brain and meninges are congested. The choroid plexus of the 4th ventricle in particular appears opaque, light yellow in colour and creamy in texture. The ventricles, aqueduct and central canal of the medulla and cord may be blocked by exudate. Impression smears stained by Gram technique will show the organism in and around cells.

Treatment consists of the administration of penicillin in large doses for at least six days. This antibiotic therapy may be enhanced by the concurrent dosing with chemotherapeutic agents such as sulphadimidine or sulphanilamide.

Myoclonia Congenita or Trembling.—This condition was described by Kernkamp (1950) as a well-known neonatal disorder with a possible familial basis. The condition is seen in piglets from birth onwards and is characterised by muscular twitchings. The ætiology is unknown. Professor H. G. Lamont has recorded the condition in the United Kingdom and his excellent film of the disorder is well known to British veterinarians.

Symptoms.—Spasmodic twitching of the general body musculature is usually the only symptom of the disease. These spasms gradually subside when the pig settles down to sleep, but any sudden noise or other stimulus wakening the piglets causes immediate return of the twitching. Excitement and noise tend to exacerbate the signs. The spasms may become so violent that the piglet is unable to move forward and may be unable to keep balance. This "dancing backwards" effect may be so violent as to make it impossible for the pig to get near its food and death from hypoglycæmia may supervene. Normally, however, the appetite remains unimpaired and the piglets lead an otherwise normal life, most of them growing out of the condition at about 6-8 weeks. They seem able to put on reasonable body weight. It may be of interest to note that Krabbe has recorded, in the human subject, cases of hypotonia which appear due to a comparative immaturity of muscle fibres, a theory supported by Lamont (1950). The signs disappear as the individuals grow and the muscle fibres "catch up" with general development.

Treatment.—There is no specific remedy for this condition and provided adequate arrangements are made for the feeding of the dancing piglets in wide shallow troughs to enable them to get to feed in spite of the spasms, no losses except those due to early hypoglycæmia or subsequent accident should be experienced.

Bacterial Necrosis.—*Actinomyces necrophorus* or necrosis bacillus is responsible for necrotic stomatitis in little pigs, and also for some necrotic fesions on the skin of the legs in young pigs. The organism is a strict anaerobe and does not produce spores, but may show a peculiar vacuolization of the protoplasm which might be mistaken for spore formation. *A. necrophorus* varies in length from coccoid forms to filaments, and is Gram negative. In the tissues the organism produces a slowly progressive coagulation necrosis, the tissue elements being reduced to a dry caseous mass, often raised above the surface of the mucous membrane. The custom in some parts of removing the canine teeth from little sucking pigs may pave the way for an infection of the pig's mouth by this organism. Lack of sunshine, fresh air and green food are also predisposing causes.

Symptoms.—Sucking pigs are usually affected. They refuse to suckle, and lie down a lot, appearing listless and unthrifty. Necrotic areas may be found on the mucous membrane of the mouth and tongue or on the skin of the legs, and in some cases the body skin may be involved. The mucous membrane affected sloughs off and there is some throat swelling. The pigs become very emaciated and die owing to their inability to feed.

Treatment.—Clean the affected parts with an antiseptic solution or a copper sulphate solution. Internally sulphadimidine sodium solution gives good results. Acriflavine or iodine dressings can also be applied. The MacLean County system of washing the sow thoroughly and then removing the sow and pigs to a clean pen should be tried, and the diet of the sow attended to. The little pigs should be dosed with cod-liver oil or halibut-liver oil and an iron and copper sulphate mixture.

Hydrocephalus.—Dropsy of the brain ventricles is sometimes a congenital condition; the young animal may be born

with an enlarged head, and seldom survives for very long. On very rare occasions the writer has found a condition of hydrocephalus in bacon pigs. The condition is believed to arise following some obstruction to the exit of cerebrospinal fluid from the ventricle. This obstruction may be due to tumours or parasites, and in the pig hydatid cysts may cause such an obstruction.

Symptoms.—There may be few symptoms noticeable in the pig, as the condition is usually an acquired hydrocephalus of a chronic form in which symptoms are slow in appearing. The animal may be noticed to hold its head to one side in a peculiar manner and to be very lethargic. The pig is generally fit for slaughter before the condition is sufficiently far advanced to cause much inconvenience, and it may not be suspected until discovered at a post-mortem examination. No treatment is therefore called for in the pig.

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Chapter 9

DEFICIENCY DISEASES AND METABOLIC DISORDERS

A NUMBER of disease symptoms are set up, notably in young pigs, when the diet or conditions under which the animals are kept is defective. A deficiency of vitamins and of minerals in the ration, for instance, sets up symptoms which are often spoken of as though they were diseases in themselves—*i.e.* pig anæmia, scour in pigs, etc.; these conditions are really symptoms of cumulative effects of bad feeding, housing and sanitation. The modern method of intensive rearing and fattening of pigs, by which every ounce of food is rationed and the pig expected to make the fullest use of it, exercise is severely curtailed, and young animals, which naturally desire some fresh air, sunlight and a run at grass, are deprived of these necessities; born and reared in a warm building, transferred to another for the process of fattening, encouraged to feed from the trough at an early age, and fed to slaughtering weights at record ages—all this serves to upset the natural physiological process in the animal's body, and brings a trail of disease symptoms in its wake. The more unnatural the treatment given to the pig, the more disease follows, and these various deficiency conditions are easily preventable provided the knowledge regarding pig feeding and pig husbandry is applied with due regard to certain fundamental natural requirements. A young animal requires some good food, sunshine, fresh air, exercise and access to pastures if it is expected to grow into a healthy animal.

Mineral Deficiency.—The minerals which are most likely to cause trouble in pigs when deficient in the ration are iron, copper, calcium, magnesium, phosphorus and iodine. Mineral deficiency and avitaminosis are closely linked up, and it may be that a ration may contain all the necessary minerals but is lacking in some of the vitamins, or the minerals may be present in the food in a condition which renders them incapable of being properly assimilated by the animal body.

Certain vitamins are known to exert a profound influence upon the metabolism of some of the minerals, examples being vitamin C and its effect upon blood formation, and vitamin D with its effect on the calcium-phosphorus balance in the body. A pig may thus be diagnosed as suffering from mineral deficiency when it may really be a vitamin deficiency that is at the root of the trouble, and it would perhaps be more correct to group these conditions under one heading, calling them food deficiencies, rather than dealing with them as though they were two distinct conditions, mineral deficiency and vitamin deficiency or avitaminosis.

In practice some of these conditions have already been separated in the lay mind in accordance with the chief symptoms—*e.g.* anæmia, scour, rickets, etc. All these are really symptoms, and they may be shown in a variety of deficiency diseases, and it would appear to be a mistake to regard them as being due to deficiency of one specific factor. It is customary to regard pig anæmia as being due to iron deficiency and rickets as a calcium deficiency, but a variety of factors are concerned in each condition, and the role played by vitamins is of fundamental importance in pigs, both in the so-called deficiency diseases and in specific diseases and local conditions, a classical example being pig paratyphoid of the non-Salmonella type.

A condition of diarrhœa with yellowish-white fæces is a common symptom accompanying anæmia, and is found in pigs suffering from mineral deficiency, avitaminosis, etc. The condition is often spoken of as though it was a specific disease of pigs, but it should be regarded as purely a symptom, just like anæmia. The latter is often the result of an acute diarrhœa. This condition of scour in young pigs may be set up as a result of mineral deficiency in the sow's milk and the ration; it is also found in avitaminosis, the usual picture being anæmia, scour, stunted growth, with possibly abscess formation subcutaneously. The symptoms are similar to those shown in anæmia; the pigs will often lick the pen walls, eat their bedding, etc. A post-mortem examination may reveal, besides anæmia, an impaction of the stomach with food containing quantities of straw and litter, whilst the intestines contain no solid food.

The condition responds to the same treatment as prescribed for anæmia, and a little **calcium** added to the food will be useful.

Rickets, also known as **rachitis,** is the name applied to a well-known disease of young animals caused by a lack of vitamin, notably vitamin D, which appears to have some effect upon the calcium-phosphorus absorption by the body. A low calcium ration will produce rickets, as also will a low phosphorus diet, whilst magnesium metabolism is closely linked with that of calcium, and the first manifestation of a magnesium deficiency may be a retention of calcium. It has been found that when the blood calcium falls below 8 mg. per 100 ml., symptoms of rickets will begin to appear. Phosphorus and calcium form about three-quarters of the body ash and more than 80 per cent. of the mineral matter of bone; they are present in protoplasm in blood and milk. An organic phosphorus compound, phytin (inosite hexaphosphate), is present in certain cereals, especially maize. The phytin-splitting enzyme "phytase" is not present in maize, but is found in rye, wheat and barley. Oats and oil cakes are also deficient in phytase Under the action of phytase, the phytin gives up its phosphorus in a soluble and absorbable form, so that phytase thus acts as an antirachitic factor in the diet. Of the vitamins, A, B and D are accused of being implicated in the causation of rickets. Vitamins A and D were at one time regarded as one vitamin rather than two, and it is now known that vitamin A is the growth-producing vitamin, its absence in the diet resulting in stunted growth. Vitamins B_1 and B_2 and C do not appear to be of as much importance in this disease in the pig as vitamin D, which is also known as the antirachitic vitamin. In the absence of this vitamin from the diet the calcium-phosphorus balance in the body is upset. Calcium is excreted from the body at a higher rate than it is taken into the body. These vitamins also seem to affect the parathyroids (see Vitamins). It has been observed in experimental animals that if the parathyroids are removed from the body, with only a trace left, one of the effects is defective calcification of the teeth, and a probable decrease in the blood calcium.

It is evident, therefore, that rickets is due to a series of factors, including a deficiency of vitamin D, calcium, phosphorus, magnesium, and a general lack of conditions enabling

these factors to be supplied to the animal body—*e.g.* lack of green food, sunshine, exercise, a badly balanced diet, mineral deficiency, etc. At one time rickets was thought to be hereditary, but the only way the disease could have been thought to be hereditary is through the birth of weakling piglets from a sow which was on a rachitic-producing diet.

Symptoms.—The disease affects young pigs, and is not very rapid in its onset. Growth is retarded, the joints may be swollen, the limb bones become bent under the body weight, the head may be enlarged in proportion to the rest of the body, emaciation and general unthriftiness are apparent, with

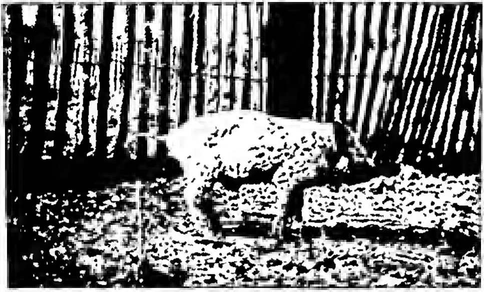

FIG. 68.—A PIG SHOWING STUNTED GROWTH, ARCHED BACK, ROUGH COAT WITH ABSCESS FORMATION, ANÆMIA AND SCOUR.

some diarrhœa, often scour, and anæmia. The young pigs will eat their bedding, lick the pen walls, and may readily gobble up any ashes or bits of mortar thrown into their pen. They appear very hairy, with pendulous abdomens; later the animal may become very emaciated, the abdomen being tucked up, razor-backed, and abscess formation may be noticed along the back, flanks and hams. Paralysis of the hindquarters may supervene, and death may occur from exhaustion or from infection with some pathogenic organism.

Post mortem.—The carcase has an unthrifty appearance; there may be evidence of anæmia, impaction of the stomach

with much straw, etc. There is an enlargement of the ends of the long bones of the limbs, with a thickening of the cartilages and a softening of the compact tissue of the bone.

Treatment.—Preventive treatment should consist in the provision of a balanced ration for both sows and pigs, with due attention to hygiene in the housing and management of the stock. There should be some access to green foods, pasture-land, etc. Curative measures should include a change of diet and conditions under which the young pigs are kept, the provision of calciferol (vitamin D), and halibut-liver oil, which, although more expensive than cod-liver oil, is more potent in its vitamin content (A and D), and requires only a very tiny dose. Capsules of concentrated vitamin extracts may be administered, and the symptoms of diarrhœa and anæmia treated as prescribed for those conditions. The addition of calcium borogluconate crystals to the feed, with a good mineral and vitamin tonic, will often work wonders in rickets.

Osteoporosis, also called sometimes osteomalacia, affects adult pigs, occasionally when the animals have been badly neglected either deliberately or through ignorance of the elementary principles of feeding. In this condition the lime salts are removed from the bones and the calcium-phosphorus ratio is upset as in rickets. Bone tissue is thus replaced by organic matter and the bones are softened and enlarged.

Symptoms.—Very similar to those of rickets in the young animal, but the head is more often affected in this disease, notably the superior maxilla. The teeth may become loosened, the jaws become malformed, the limb joints may be swollen, and bones may be easily fractured. Emaciation sets in in spite of a good appetite. The animal will lick lime-washed walls, eat ashes, bits of mortar picked out from walls, etc.

Post-mortem findings are very similar to those seen in rickets in the younger animal, with a softening of bones and some malformation of the jaw bones and loose teeth.

Treatment.—As the condition is believed to be due to lack of calcium, or an interference with the calcium-phosphorus ratio, in which vitamin D plays an important part, the administration of concentrated vitamin is advisable, and this may be found in substances like halibut-liver oil, cod-liver oil, and wheat-germ oil. An adequate ration with mineral supple-

ment should be provided, and the defects in feeding and housing corrected. (See Anæmia and Rickets.)

Avitaminosis.—In dealing with some of the deficiency diseases, mention has been made of the role played by vitamins, notably vitamins A and D, in the prevention of mineral deficiency. It is seldom that vitamins alone are lacking; as a rule there is an accompanying mineral deficiency, and the ration may be badly balanced.

VITAMIN A.—The accessory food factors termed A_1 and A_2 belong to the fat-soluble vitamins, and are normally present in green plants such as cabbage, clover, spinach, carrots, turnips, tomatoes, halibut- and cod-liver oils, whale oil, animal fats, milk, butter, egg yolk, internal organs such as the liver and kidneys. These vitamins are the anti-xerophthalmic and anti-infective factors arising from the breakdown of the plant pigment β-carotene. A_2 has been found in the liver oils of fresh-water fish.

It is possible for pigs to be fed on an apparently satisfactory diet and yet to develop avitaminosis A, as many of the pig rations used in pre-war years were deficient in this food factor. The reserve of vitamin A in the young pig may be high enough to tide over a long period, so that symptoms of deficiency may not appear until the animal is over four months old.

Symptoms.—Inappetence and lethargy are the first noticeable signs of deficiency of this vitamin. The coat appears dull and dirty, eyes staring, and the head may be held on to one side. In the breeds with non-pendulous ears, one ear droops. Pigs become very restless and irritable, gait is abnormal, and some stiffness appears in the hindquarters. Sows remain on heat for a long period. In advanced cases convulsions appear preceding collapse from complete exhaustion. Pigs stagger and fall over on one side, screaming. When the fit has passed the animal lies exhausted, choreic symptoms develop, breathing is gasping, heart beat very irregular. Use of the limbs, or of the hindquarter in particular, may be completely lost. Death may be sudden in some cases, and sows kept on land which is devoid of any green pasturage will farrow dead piglets.

Post-mortem examination shows no lesions that can be described as characteristic of avitaminosis A. The chief changes are in the gastro-intestinal tract, in the form of in-

flammation and thickening of the mucosa. Some inflammation is also to be found in the heart muscle, with congestion of the liver, lungs and kidneys.

Treatment.—Provide green food containing the vitamin A factors, or add vitamin A concentrate to the ration. Large doses of vitamin A concentrate, as high as 500,000 international units, given to young pigs will tide them over until ready for slaughter.

VITAMIN B.—This factor, or series of factors, belongs to

FIG 69.—MARMITE DISEASE. AFFECTED PIGLET.[1]

the water-soluble vitamins. B_1 is the antineuritic factor whose absence from the diet is said to result in growth failure, polyneuritis, and death in young animals. It is believed to have some effect upon carbohydrate metabolism. B_2, or riboflavine, is the factor necessary to the normal oxidizing system of tissue cells. Its absence from the food leads to the hair falling out, the skin becoming scurfy, and a dermatitis is set up similar to pellagra. Vitamins B_3, B_4, and B_5 are growth factors detected in animal experiments, whilst B_6 is the rat anti-dermatitis vitamin. There is also the P.P. factor

[1] Marmite disease of 3-5 week-old piglets is associated with Vitamin B deficiencies An effective treatment is Marmite applied to sows' teats.

(pellagra-preventive), or nicotinic acid. The latter and the B_1 factor are the B vitamins whose absence from the ration causes most concern in the swine world. These series of accessory food factors are found in yeast, tomatoes, the embryo of cereals, spinach, carrots, cabbage, onions, turnips, beet leaves, peas, lentils, beans, nuts, milk, liver, heart and brain. Feeding with a ration deficient in vitamin B for a period will lead to a condition summarized as follows:

Symptoms.—Growth ceases following inappetence. Pigs

FIG. 70.—MARMITE DISEASE. CLOSE SHOT OF SKIN OF AFFECTED PIGLET.

are lethargic, coats become dull, later harsh and staring. There is occasional vomition, the animal becomes emaciated, hair falls out. The heart beat is irregular, and pulse rate increased on slightest exertion. There is a progressive paralysis of the hind-legs, and diarrhœa. Other factors, such as the onset of pneumonia, scour and anæmia, complicate the condition. In other cases (B_6 deficiency) the skin of affected swine appears pallid, and the animals run about as though terrorized. They scream and drop as if shot, with limbs extended, manifesting tonic spasms. Next the legs are jerked violently, there is a grinding of teeth and urine is discharged.

This stage is followed by coma. Respirations are at first deep and stertorous, later becoming shallow, the pig lying as though dead. In a few minutes colour returns to the skin and consciousness is regained, the animal apparently being none the worse. These epileptic fits last for periods varying from a few minutes to a quarter of an hour. Minor epileptic conditions are also found in which swine appear dazed and bump into obstacles. A blood examination of such animals shows evidence of a microcytic anæmia. The diameter of the erythrocytes is much reduced.

Post mortem.—Emaciated carcase with long rough hair. There are lesions of inflammation of a diphtheritic and ulcerative type in the digestive tract and nasopharynx, similar to the lesions encountered in swine paratypboid. (Attempts to isolate *Salmonella suipestifer* in pigs dead from vitamin B deficiency have not been successful.) There is some peritonitis, and in cases of B_1 deficiency heart lesions have been encountered. These heart lesions consist of a state of dilatation without hypertrophy, with some areas of necrosis on the auriculoventricular valve, or in the auricles and occasionally in the ventricles.

Treatment.—Normal pig food (pre-war) contained some wheat offal and some whole grain, so that a deficiency of vitamin B factors was hardly likely to occur. A good supply of vitamin B can be obtained from brewer's yeast. If fresh yeast is used in large quantities it will cause digestive disturbance by fermentation inside the stomach, and should be first heated to prevent this happening before feeding to swine. Dried yeast has been found to be more stable and more palatable than the fresh variety. The feeding of nicotinic acid, especially in early stages, exerts a markedly beneficial effect. Subcutaneous and intramuscular injections of vitamin B_{12} and of many others are in regular use for the treatment of avitaminosis.

VITAMIN C (ascorbic acid).—This is the antiscorbutic factor, and is a water-soluble vitamin, connected with the metabolism of calcium and iron in the body. Its absence from the diet of man leads to scurvy, loss of weight and unthriftiness. Chronic or even slight deprivation of this vitamin is said to affect adversely the development and maintenance of

the teeth. As most swine are not allowed to die of old age, the condition of the teeth receives scant attention, but nothing very definite is known at present as to the importance of this accessory food factor in relation to swine. It is believed that vitamin C also affects blood formation, but that it does not play such an important role in the pig's life as that of some of the other vitamins already described. There is some evidence that pigs can synthesize vitamin C in their alimentary tracts.

Vitamin C is found in fruit and vegetables, orange and citrus juices especially, as well as in germinating seeds. Meat and milk contain a little.

VITAMIN D (calciferol) is a fat-soluble vitamin whose absence from the pig's ration leads to rickets. It is thus known as the antirachitic factor, and is associated with mineral deficiency. This vitamin is found in halibut-liver and cod-liver oils, egg yolk, *fresh* green foods, and it is also obtained from irradiated ergosterol. Sunshine or ultra-violet radiation also produces vitamin D, and by irradiation of certain foods the D factor may be increased. In swine, absence of this vitamin from the food leads to an upsetting of the calcium-phosphorus balance in the body. Calcium is excreted at a higher rate than it is taken into the body. Vitamin D prevents this loss by re-excretion into the gut lumen, thus creating more favourable conditions for the calcification of growing bone. It is believed that the vitamin does this by bringing about a change in the reaction of the bowel contents favouring absorption and retention of bone-forming minerals, including phosphates in particular. (See Rickets.)

VITAMIN E is the fat-soluble antisterility factor, or perhaps it would be more correct to call it a series of factors, as it is believed that more than one is involved. It plays an important role in the reproductive cycle, through the anterior lobe of the pituitary gland. Females deprived of these E factors show a type of sterility, pregnancy being terminated by the death and resorption of the fœtus. A deficiency of this vitamin in the male causes premature degeneration of the spermatogenic tissues. In general, the absence of this factor from the food is believed to cause abortion, sterility, stunted growth, birth of small litters, dead and unthrifty piglets. Lack of vitamin E may also be associated with muscular dystrophy.

The pure vitamins have been isolated as colourless, viscous oils. They are found in most green vegetables, particularly in lettuce, wheat germ, maize and hemp seeds, the richest source being the oil extracted from wheat embryo.

VITAMIN K is one of the fat-soluble group, and is the anti-hæmorrhagic factor. It is the vitamin which assists in the formation of prothrombin, and has been found useful in the treatment of obstructive jaundice where the prothrombin content of the blood is low. It is found in green leaves, certain green vegetables, and in liver. It is present in alfalfa, cabbage, spinach, strawberries, ripe tomatoes, the soya bean, as well as wheat embryo and potatoes, in small quantities.

VITAMIN P.—This is associated with ascorbic acid (vitamin C), and is a water-soluble vitamin found in lemon juice. It is said that this factor supplements the action of vitamin C in certain types of nutritional disorders.

Parturient Hypocalcæmia.—A form of " milk fever " sometimes occurs in the sow and may affect animals in good condition. The condition would appear to be a hypocalcæmia similar to that occurring in the cow, a species which has received considerable attention in relation to this disorder in recent years. The early observations of Dryerre and Greig supporting parathyroid dysfunction as a major factor in the production of the disorder have returned to favour particularly in view of American work. Selye has suggested that it is an adaptation syndrome. The main result is a fall in the blood calcium level with in some cases an associated fall in blood phosphorus. Some authorities believe that blood magnesium levels may also be involved, but a marked fall in this mineral is usually associated with hyperæsthesia or even tetany and its complicating influence should therefore be differentiated from the comatose state produced by hypocalcæmia with or without hypophosphatæmia. Very few references have appeared, however, in relation to the pig.

Symptoms.—Sows may be attacked within a few hours of farrowing, but in not a few cases a similar syndrome is noted in animals which have farrowed 7-10 days previously. The sow's appetite and milk secretion fall off rapidly. The animal appears restless at first but later is found lying down. If she is roused she may make some inco-ordinated movements on

her feet or may be unable to get up at all. Within a matter of hours consciousness is gradually lost and the sow passes into a comatose state.

Treatment.—This consists of the subcutaneous injection of a solution of calcium borogluconate containing in addition a soluble phosphate. Up to 1 oz. of the calcium salt may be given diluted with about 5 parts of water and sterilized before administration into the loose subcutaneous tissue behind the ear. Proprietary solutions are available containing calcium, phosphorus and even magnesium salts if the latter are thought necessary. The condition is not as acute as the similar syndrome in the cow and the need for the intravenous administration of at least part of the dose would seem to be obviated.

Hypopituitarism in Sows.—This condition may occur in sows within three days of farrowing, and characteristic symptoms are inappetence, constipation, and a high temperature. Affected animals lie down and show marked reluctance to move. If forced on their legs they will soon assume a recumbent position again, and appear to be very stiff in the joints. The mammary glands may be swollen, and milk may only be expressed with great difficulty, or not at all. Treatment consists in the injection of anterior pituitary-lobe extract into the region of the mammæ in doses of from 2 to 4 ml. The mammary gland should be massaged well to assist a return of the milk flow.

Agalactia.—This term refers to the failure of the sow or gilt to secrete milk or to secrete it in quantities adequate for the feeding of piglets (dysgalactia). There are a great many possible causes, some being associated with failure to manufacture milk, others with the failure of the let-down mechanisms and still others with the inability of the mother to suckle her young even though milk is present in the udders. One of the commonest causes is puerperal fever or post-parturient fever and agalactia is only one of the symptoms which commence with inappetence, listlessness, recumbency with teats under the sow to prevent the piglets getting at the tense and tender udders. The temperature is elevated and a vaginal discharge is present. In large establishments it often affects a number of sows and tends to spread as an infectious disease. (See Metritis and Mastitis.)

Non-infective agalactia includes failure of the let-down mechanism despite mammary glands which are well developed and appear to be hard and congested. It will be found, however, that the nipples and galacteriferous sinuses are slack and do not contain milk. The treatment, which consists of the injection intravenously or intramuscularly of posterior pituitary hormone, produces spectacular results as milk immediately appears at the teats and the sow and litter rapidly become comfortable. The intravenous route of administration is to be preferred. A very similar condition is seen where the response to pituitary extract is only transient and other mechanisms must be suspected. In these cases however the injection intramuscularly of 500 I.U.s of chorionic gonadotrophin often evokes a satisfactory and effective response. Following the review of swine agalactia given by Cross (1957), Noble *et al.* (1960) have suggested that satisfactory results using a combination of prednisolone and streptomycin or oxytetracyline (according to type of infection present) may be obtained in those cases which fail to respond to pituitrin. A rarer type of dysfunction is concerned with the failure of the anterior pituitary to produce enough prolactin. In this case the mammary development is inhibited and there may be almost a complete absence of secretory tissue. There is no satisfactory treatment. Inherited defects such as inverted nipples, absence of teats, and blind teats are responsible for some cases of agalactia. None of these is amenable to treatment.

Should the agalactia be a symptom of a specific condition appropriate treatment of the primary cause is essential to restore mammary function. In a number of cases the latter may be too late and suitable steps must be taken to provide the litter with an alternative source of food if heavy losses are to be avoided. A form of agalactia due to feeding pregnant sows with an ergot contaminated food has been reported from America and Rhodesia. In this the sow fails to develop the hypertrophy of the mammary glands normally associated with pregnancy. (See Ergot poisoning.)

Iodine Deficiency.—A deficiency of iodine in the food may also affect growth in the young animal as well as being the cause of goitre. It is known that land and water deficient in iodine may result in the production of cases of congenital

goitre. This condition is rare in pigs at present, but a small trace of potassium iodide as a mineral element in the pig ration often proves valuable in improving the general health of young pigs.

Anæmia.—See Chapter 8—Neonatal Diseases.

Parakeratosis is the name given by Kernkamp and Ferrin (1953) to a condition affecting the epidermal layers of the skin of young pigs from 6 to 20 weeks of age. The cornified layers are desquamated in profusion and material accumulates on the skin surface in the form of hard dry crusts. The skin covering the limbs, tail, ears, face and upper parts of the sides of the body are usually involved, and although extensive changes of a non-inflammatory nature may be noted, the condition is to a large extent self-limiting, resolution often being spontaneous and complete. The ætiology is still undecided, but was originally thought by Tucker and Salmon (1955), Hoekstra (1955) and others to be associated with a low zinc content in the ration associated possibly with a high calcium level. Various workers in N. America where the condition was widespread have reported beneficial results in the feeding of zinc supplements. Hanson and Sorensen (1957) related the disease to deficiency of essential fatty acids. The inter-relationship between the minerals and the fatty acid metabolism should be considered. As a condition associated with cold winters and springs, it has been reported as occurring in parts of the United Kingdom and the continent of Europe.

Symptoms are characterized by the development of hard crusts which, however, are preceded by the appearance of small macules and papules present very often in symmetrical arrangement, but only for a short time. Within a day or two, crust formation is marked and soon extends to cover the whole of the affected areas. Fissuring occurs to split the crust into irregular lumps which can be detached fairly easily from the underlying surface. The crusts themselves are dry and friable and discharges are absent unless secondary infection has taken place. Pruritus is not marked, but the pigs may not thrive. Mortality, however, is extremely low unless complications develop.

Parakeratosis must be differentiated from sarcoptic mange which is characterized by the presence of reddened papules in the early stages and thickening and folding of the skin in later

stages with only minor desquamation. Pruritus is very marked, especially after the pigs have been exercised or are placed in warm surroundings. The presence of the mite itself in large numbers will help to confirm diagnosis, though it should be borne in mind that mites may be found on normal pigs and that mange and parakeratosis may coexist.

Treatment consists in providing a diet containing under 1 per cent. calcium to which a supplement in the form of zinc carbonate at the rate of 0·02 per cent. has been added. Zinc sulphate may be used instead of the carbonate. Approximately ½ lb. of each per ton of food gives the required amount per pig. Kernkamp advises the addition of soybean oil to provide essential fatty acids, these being added fresh every day to avoid rancidity.

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Chapter 10

MISCELLANEOUS CONDITIONS

THESE conditions are characterised by pathological lesions primarily in some organ or part of the body with a general systemic disturbance occurring as a secondary character.

Post-pharyngeal Abscess.—Abscesses in this region are generally traumatic in origin, and are due to swallowing some foreign body with the food—*e.g.* a piece of wire, nail, or

FIG. 71.—A HAIR BALL FROM THE STOMACH OF A PIG.

sewing needle. Any visible swelling should be fomented and lanced with antiseptic precautions, the abscess cavity washed out with an antiseptic solution, and the foreign body removed.

Gastritis.—Apart from the inflammatory conditions of the stomach found in certain specific diseases in the pig, a gastritis may be caused by irritant substances in the food, poisons, and occasionally the presence of a hair ball in the stomach may set

up a local inflammation. These hair balls are derived from the pig's bristles and occur in a spindle-shaped mass. As a rule their presence is not usually suspected during the animal's life, but they may account for some unthriftiness and recurrent attacks of indigestion in affected pigs. Ascarides are another cause of gastritis in pigs, and some ulceration of the mucous lining of the stomach in pigs has been found to be caused by *Streptococcus viridans*. In America it has been found that 1 in 20 pigs' stomachs may show ulcerative lesions. These are usually found in the late winter and early spring months.

Symptoms.—In acute gastritis more than one pig in the herd may be affected, especially if it is due to some irritant in the food or to the presence of worms. There may be some vomiting after feeding, a marked thirst, and some urticaria noticeable on the skin in the form of a diffuse rash or as small red spots. Convulsive symptoms may appear in young pigs, particularly when the condition is due to worms.

Post mortem.—One may find a patchy inflammation of the mucous membrane or some ulceration and hæmorrhage into the submucous tissue. The ulcers may be very small, and the patchy inflammation should not be confused with the physiological congestion of the stomach wall so often observed in slaughtered pigs.

Treatment.—The administration of an oily purgative followed by gastric sedatives, and where worms are suspected, the administration of vermicides such as piperazine, oil of chenopodium, sodium fluoride or santonin. Carbon tetrachloride in capsular form is also useful. (See *Hyostrongylus rubidus*.)

Impaction of the Stomach (Stomach Staggers).—This condition is usually found where there is some mineral or other deficiency in the ration. (See also Bowel Œdema.)

Symptoms.—There may be some vomiting after feeding, with convulsions in young pigs, and a general unthrifty appearance. The skin appears very hairy, the back is arched, and there is a pallid skin with anæmia. Some diarrhœa or scour, and discoloration of the ears, may also be present. The pigs may be noticed licking the walls of the pens and eating their bedding, and there may be some fatalities.

Treatment.—A properly balanced ration should be provided and the vitamin and iron treatment advised for anæmia and

the deficiency diseases carried out. The condition in store pigs may not be suspected until there are a few sudden deaths in the herd. All that will be found on post-mortem examination will be evidence of anæmia, and the stomach will be impacted with undigested food containing a lot of straw and roughage from the litter. The food normally fed to pigs is not likely to cause this condition, and it is when there is a

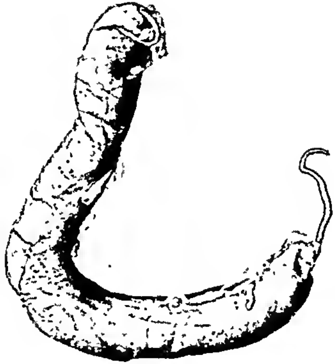

FIG. 72.—PORTION OF THE SMALL INTESTINE OF THE PIG, SHOWING IMPACTION WITH *Ascaris lumbricoides* (*A. suis*).

dietetic deficiency that this impacted state of the stomach is usually encountered.

Enteritis.—Inflammation of the bowel in pigs is often associated with some specific disease, but enteritis and gastro-enteritis also occur following on the ingestion of some irritants in the food, poisoning, and a heavy worm infection. Feeding of roots such as swedes and mangolds during frosty weather seems to cause an acute enteritis in sows. There is also an

infectious enteritis which may spread throughout whole herds. (See Paratyphoid, Infectious Enterohepatitis and Transmissible Gastro-enteritis of Piglets.)

Symptoms.—The affected animal may refuse any food, and lie down stretched out on its side. The temperature at first is normal, later it rises some degrees and an initial period of apparent constipation is followed by diarrhœa, which later becomes blood-stained. The pigs lie prostrate. The temperature drops after about twenty-four hours to subnormal, and death occurs in some cases within a few days of the first onset. In other cases the animal becomes comatose, with recurrent spells of consciousness, when it will get up and bump into the sides of the pen and show evidence of acute pain.

In the transmissible enteritis, acute diarrhœa is the main symptom, with loss of weight and condition. Sows may be infected within a few days after farrowing or before. The diarrhœa in the newly born pig often has a green tint, and may cause death in one or two days in the very young. Infection seems to start in the adult stock.

Post mortem.—In the infectious kind the pinkish skin colour is noticeable, with some dehydration, if the diarrhœa has been severe. The stomach lining may show hæmorrhages in the pyloric region, or else active inflammation and even ulceration. The jejunum is inflamed, and a hæmorrhagic enteritis exists in the intestines. The kidneys are either paler than normal, or show subcapsular petechial hæmorrhages. The cerebellar blood vessels are congested, and some encephalitis is present.

Treatment.—Any offending substance in the food should be removed and the ration corrected. Gastro-intestinal sedatives should be prescribed. If worm parasites are suspected, they should be treated with modern vermicides. In view of the association of enteritis with anthrax in pigs, it may be advisable to prepare a smear and examine for *B. anthracis.* In the infectious type, sulphaguanidine in doses not exceeding 1·5 grammes per 10 lb. body weight daily can be given, half the dose in the morning and the other half in the evening feed. The drug can be administered either in the mash or in capsule form. (Toxic symptoms supervene if the dose is increased to exceed 2 grammes per 10 lb. body weight daily.) Phthalyl-

sulphathiazole (Sulfathalidine) also has a markedly beneficial effect on this condition.

Oxytetracycline (Terramycin R) and chlortetracycline (Aureomycin R), (soluble powder 25 g. of oxytetracycline hydrochloride activity per lb. of feed), are given orally in 100 mg. capsules for pigs weighing from 2 to 5 lb., about 3 times with 12-hourly intervals. Sows can be intramuscularly injected with 2 g. oxytetracycline each, and so save time and labour. (1 g. is believed to be enough to produce therapeutic levels in

FIG. 73.—TORSION OF THE INTESTINE WITH NECROSIS OF THE DISTAL PORTION.

the sow's milk.) A combination of sulpha preparations plus streptomycin is useful in pigs of all ages.

Constipation.—This is usually a symptom of bad feeding, insufficient water, obstruction, or of some specific fever. Lack of tone in the bowel wall and the arrest of intestinal secretions cause the passage of fæces to be suspended.

Symptoms.—There is a total absence of fæcal passage and a lack of appetite, with a depressed and listless attitude. Visible mucous membranes may be dirty-yellow. There may be no rise in temperature in the early stage, but later the

temperature may rise a few degrees. The urine may be darker in colour than normal and may precipitate salts on standing. Convulsive symptoms due to auto-intoxication may be seen in young animals.

Treatment.—Mild oily purgatives. Calomel or Istin (Bayer) may be given, with hot enemata. The injection of carbamylcholine or phenolphthalein in suitable doses is a convenient way of overcoming the condition. The cause of the condition should be looked into and removed. The food must be laxative and tonics should he presented following relief of the main symptoms.

Intussusception.—In this condition one part of the bowel becomes telescoped into another part. The anterior part becoming telescoped into the posterior is the usual rule, and it is a condition generally found in young animals. It may be due to improper feeding or worm parasites in the intestine. The telescoped parts may become adherent and inflammation with necrosis of the part may set in.

Symptoms. These are similar to those of acute colic, and there may be some blood clots passed in the fæces. With excessive straining the rectum may become prolapsed.

Treatment is not satisfactory in the pig, and it may be best to have the animal slaughtered, as the expense and trouble of operative treatment are seldom justified in small pigs.

Volvulus.—Volvulus or twist of the bowel in pigs usually occurs in young animals following strangulation of the bowel in hernias, and acute peritonitis with adhesions. The symptoms are very similar to those of intussusception, and slaughter is usually resorted to rather than operative treatment.

Strangulation of the Bowel.—This occurs sometimes in cases of umbilical hernia in young pigs. The loop of intestine in the hernial sac becomes filled with food, and is unable to pass out of the sac. The affected part of the intestine becomes congested, and there may be an acute inflammation with gangrene. The skin over the hernia may also be inflamed. The condition is best dealt with by the immediate slaughter of the young animal so as to salvage the carcase. This condition may also occur as a result of strangulated *scrotal hernia*, but it is usually the umbilical hernia that provides most of

these cases in pigs. *Diaphragmatic hernia,* in which a loop of intestine is passed through a hole in the diaphragm into the chest cavity, is sometimes encountered in little pigs also, generally as a result of some pressure such as when a little pig tries to squeeze under a gate or fence. Such pigs will often live to slaughter age without the condition being suspected. In acute cases, and where strangulation occurs, there may be vomiting, sitting on the haunches quite a lot, and difficult respirations. Slaughter is advisable in such cases.

Proctitis.—Inflammation of the rectum is sometimes found in young pigs in acute constipation when the rectum becomes everted and protrudes from the anus. The prolapsed part should be covered with emollients and gently replaced, and a mild enema given, also laxatives and tonics. Where recurrence takes place surgical removal is advisable.

Dysentery.—Dysentery is a symptom of acute enteritis due to faulty feeding or to infection, in which the fæces may be wholly liquid and bloody. Dysentery is present in swine fever and anthrax. In the United States dysentery is an infectious disease affecting the cæcum and colon, and is caused by some organism present in these organs and their discharges in infected pigs. The condition can be reproduced in healthy pigs by feeding with the cæcum and colon or bowel discharges from diseased pigs. Doyle isolated a pure culture of vibrio from the colon wall of a dysentery pig. The incubation period is ten to twelve days experimentally, and up to thirty days in the field. The average death rate is 25 per cent., the highest mortality being in the younger animals. In simple diarrhœa and scour there is little or no blood passed in the fæces, which are yellowish-white in colour, and the cause can often be traced to dietetic or hygienic deficiencies. In dysentery, however, if the blood discharge is from the duodenum or upper part of the intestine, the fæces then are solid and black in colour.

Symptoms.—Diarrhœa, with blood and mucous discharge from the bowel. Rapid loss in weight and condition. The appetite may be fairly good. The temperature does not always rise. Death may occur suddenly, or be delayed for some days. Recovered animals appear unthrifty.

Post mortem.—There is cæcitis and colitis, but gastritis is

rare. In an uncomplicated case the small intestine shows no lesions. There is a sharp line of demarcation between normal and abnormal tissue at the ileocæcal valve. In severe cases the entire colon is red in appearance. The pathological changes in the cæcum and colon vary from congestion, hæmorrhage, and increased mucus production to the formation of a diphtheritic exudate, with desquamation of the intestinal epithelium. The deeper necrosis and infarction of swine fever are usually absent.

Treatment.—Sanitation and quarantine measures should be adopted. Dysentery outbreaks may be due to carriers. Sulphaguanidine and sulfathalidine have a curative effect on some types of enteritis, but the latter is better for dysentery. Graham and others used phthalylsulphathiazole in powder form mixed with dry food at the rate of 0·25 to 9·5 g. per 10 lb. body weight, weak animals being drenched. This treatment with sanitary precautions and a change-over to bulky food like oats and barley results in a fall in temperature in twenty-four hours, with returned appetite and improvement in condition. Streptomycin with sulphathiazole has also given good results. (See Enteritis.)

Salt has been used to reduce dehydration and so maintain a favourable chloride ion concentration in the body fluids. If salt is used it is highly important that the animals have access to plenty of clean water. A dose of ½ oz. of sodium chloride with the same quantity of sodium bicarbonate in 1 pint of water per 100 lb. body weight is given, and an old treatment is to dissolve 10 lb. sodium chloride in 50 gallons of water and soak the oats in the solution.

Simple diarrhœa and scour are treated by dietetic and hygienic measures. Powders composed of ferrous sulphate, catechu and chalk are useful, and so is a mixture of bismuth subnitrate, kaolin and carbon.

Mesenteric Emphysema.—This is a rare condition in which the portion of the mesentery adjoining the intestine, together with the peritoneal covering of the bowel, becomes converted into a mass of little air sacs. It is believed to be due to organisms of the coli group invading the mesentery and serous layer of the intestine and producing fermentation with gas production. It does not appear to affect the pig appreciably

during life, and is generally only found at a post-mortem examination.

Diabetes Mellitus.—This condition is not known to occur in the pig, but there is occasionally found a degeneration of the pancreas in pigs which may well give rise to glycosuria, the symptoms of which would pass unnoticed in a fat pig destined for slaughter. In this condition the pancreas is converted into a yellowish œdematous mass in which float some pieces of pancreatic tissue. Glycosuria or saccharine diabetes is a condition in which there is an excess of sugar in the urine, with or without an excess of water. An excess of sugar is found in the blood of affected animals. Some pancreatic cells become diseased, resulting in a deficiency of the pancreatic hormone and a failure to utilize the sugar in the food.

Symptoms.—There is a progressive loss of condition and debility, with an increased appetite and thirst, and an increase in the amount of urine. The specific gravity of the urine is also increased, in spite of its lighter colour.

This disease has not been diagnosed in pigs, the pancreatic degeneration being usually found after death, as the pigs are usually slaughtered when about six months old.

Diabetes Insipidus, or polyuria, is more a symptom than a specific disease. Large quantities of urine of a low specific gravity are passed, and the condition may be due to a mild form of nephritis, or to dietetic errors, the administration of diuretic medicines, or may occur as a symptom of some specific disease. Although the urine is of low specific gravity, the large amount passed may result in the excretion in this way of an excessive amount of solids, leading to general unthriftiness and emaciation. If the condition persists, acute nephritis may follow, with the passage of blood-tinted urine.

Treatment consists in removing the cause of the trouble by attention to the ration, the administration of purgatives and later of tonics.

The various tests for the examination of urine are dealt with in the chapter on urinary diseases.

Leucocythæmia or lymphatic leukæmia, is a disease characterized by a marked increase in the leucocytes, and a decrease in the erythrocytes in the blood, with some morbid growths in some internal organs. The condition is seldom

diagnosed in pigs during life, but is seen occasionally in slaughtered carcases in the abattoir. Affected pigs appear very anæmic with evidence of a gradual wasting. The carcase lymphatic glands are very enlarged and soft. The spleen is enlarged and somewhat firm. The tissue is filled with lymphocytes, and the Malpighian bodies become obliterated, whilst in advanced cases there is some proliferation of fibrous tissue between the blood spaces. The disease is easily mistaken by a layman for tuberculosis, and it usually goes undiagnosed during the animal's life.

The treatment indicated consists of good feeding with an adequate supply of vitamins, rest, and medicinally hæmatinics should be prescribed. Response to medicinal treatment in this disease is not very encouraging. (See Neoplasms, p. 280.)

Pseudo-Leukæmia.—This disease is also known as Hodgkin's disease or lymphadenoma, and is very similar to the former condition. It is characterized by enlargement of the lymphatic tissue in various situations of the body, and by some lymphoid growths in the internal organs. The condition is rare in pigs, but, like leucocythæmia, it is sometimes encountered in pigs up to bacon weight. The actual cause of the condition is unknown, but it is believed that an infective agent may underlie the process, and various organisms, including some Gram-positive bacilli, diphtheroids and spirochætes, have been incriminated at various times, but none appears to be the causal factor

Symptoms.—Swellings are seen in the neck region due to an enlargement of the lymph glands. Respirations are accelerated, and if driven any distance the animal soon falls out and lies down on the wayside. There is some anæmia; the skin and visible mucous membranes appear pallid.

Post mortem.—The superficial lymph glands are very much enlarged, and the spleen is also sometimes considerably enlarged, the capsule being thickened and adherent to the adjacent tissues. The spleen may contain rounded or irregularly shaped nodules about the size of a pea and yellowish in colour, representing areas of connective-tissue proliferation. Similar nodules may be found in the liver, and there may be a secondary anæmia The enlargement of the lymph nodes can be general throughout the carcase, or else localized to one

group of nodes only. The enlargement is sometimes great enough to give the nodes the appearance of large tumours.

Treatment.—The condition is very rare in pigs and is seldom suspected clinically. Treatment follows that laid down for leucocythæmia, with the addition of iodides in order to reduce the glandular swellings.

Biliary Congestion (Jaundice).—This condition can be due to an invasion of the bile ducts by ascarides from the intestines, or to the liver fluke, or a catarrh of the bile ducts in cases of enteritis and certain specific diseases. Cirrhosis of the liver, tuberculosis, hydatid cysts in the liver pressing on the bile ducts, may all cause this condition, as will the presence of gall-stones or concretions in the gall-bladder.

Symptoms.—A yellow colour in the skin and mucous membranes is characteristic of this condition, with general dullness, lack of appetite, and a gradual wasting. Constipation may be present, the fæces being offensive in odour; the urine may be very yellow and will contain bile salts and pigments. The affected pig may have a pendulous abdomen with some œdema and some anæmia. On post-mortem examination a pronounced yellow colour is found throughout the membranes, connective tissue and fat. The condition should be distinguished from the yellow colouration due to dietetic causes such as the feeding of excessive quantities of inferior fish oils. In the latter case the fat and tissues are stained a light chocolate tint and the skin may not show any yellow colour.

Treatment consists in giving calomel, with salines such as sodium sulphate or magnesium sulphate. Vermifuges should be given where worms are suspected as being the cause—oil of chenopodium, santonin, or male fern. Calomel and santonin may usefully be combined in powder form.

Bacterial Necrosis of the Liver.—This condition is rare in pigs, but is occasionally seen in sows' livers at a post-mortem examination. The cause is an invasion of the liver by the *Fusiformis necrophorus*, and the symptoms closely resemble portal congestion. In advanced cases there may be some jaundice, œdema and emaciation, but as a rule the necrotic liver is only found after death, and the carcase may be in quite good condition.

Treatment.—Should this condition be suspected, treatment with sulphonamides may be worth trying. Cholagogues and saline purgatives should also be used. The synergistic action of antibiotics and chemotherapeutics is worth while applying.

Degenerations of the Liver.—Fatty degeneration or amyloid degeneration of the liver may be secondary to some acute fever, or the result of poisoning by arsenic, lead, mercury, etc., or to dietetic errors. Most of these cases of liver degenerations are not diagnosed during the animal's life, and many of the so-called fatty livers found in pigs are not degenerations in the true sense that there is a substitution of normal liver cells by fat, but are rather *fatty infiltrations*, where there may be an excessive quantity of fat in the liver substance without a decrease in the liver cells. These conditions are believed to be due to dietetic troubles, and treatment should be designed towards an improvement in the hepatic functions by the administration of salines, cholagogues, etc., and a reduction of carbohydrates in the diet.

Rupture of the Liver.—Occasionally a rupture of the liver of a fat sow with a "fatty infiltrated" liver may occur from fighting with other sows, or during loading and unloading from transit wagons. The symptoms are similar to those of internal hæmorrhage—viz. a running-down pulse, pallid mucous membranes, shivering, and the extremities such as limbs, ears, etc., become very cold. The temperature falls to subnormal, and, following a comatose stage, death occurs.

Immediate slaughter to salvage the carcase is best, as the extent of the rupture is such that the internal bleeding cannot be arrested by any drugs.

Cirrhosis of the Liver.—This form of chronic interstitial hepatitis is found in pigs of all ages, the commonest form being the "milk-spot" type of cirrhosis in which islands of fibrous tissue are found spotted on the liver surface. This condition is believed to be parasitic in origin, due to the larvæ of ascarides and young flukes. *Fasciola hepatica* is sometimes found in the bile ducts of the livers of adult pigs, especially sows, but is not so common in fat pigs, as these are not generally allowed exercise on pasture-land. In fat pigs it is the ascarides that may invade the bile ducts and set up a diffuse cirrhosis through the liver tissue, or hydatid cysts may also cause an

irritation leading to cirrhosis. It is usually in old sows in which is found the hypertrophic cirrhosis in which there may be an enormously enlarged liver, tough as leather. In other cases there may be an atrophic cirrhosis, but the real "hobnail liver" is not so common in pigs as the parasitic type. That

FIG. 74.—CALCIFIED ECHINOCOCCUS CYST WITH CIRRHOSIS OF THE LIVER (SOW).

the migrating larvæ of *Ascaris suis* are the cause of chronic focal interstitial hepatitis in swine has been suspected for some years, and valuable work by White brought knowledge of the condition a stage further and focused attention upon the damage wrought by these parasites both in pig livers and as a cause of swine pneumonia. Oldham and White describe how the first stage larva appears in the ascaris egg *in vitro*

about the eighth day and the first moult about the eighteenth day, after which the parasite is infective. Incubation for twelve weeks increased the proportion of infective eggs. Pigs fed with such material showed the milk spot liver in various stages.

Examination of livers from infected pigs showed a central hæmorrhagic zone with liver cell destruction and an intense eosinophile infiltration followed by absorption and repair. The interlobular septa adjoining had abundant fibroblasts. Although most of these lesions, to the naked eye, appear to be on the liver surface, Oldham and White were able to demonstrate some in the deeper-seated liver tissue. The invasion of the liver, lungs and kidneys is through the blood stream.

Symptoms.—These may be almost non-existent and pass unnoticed during the animal's life. This is especially the case in the common type of milk-spot cirrhosis, but in adult animals affected with the hypertrophic or atrophic type there is some sign of general unthriftiness and even emaciation, and jaundice may be a prominent symptom, together with a pendulous abdomen and some ascites.

Treatment.—This is seldom called for in young pigs, as the condition is not suspected. Owing to the frequency with which internal parasites are associated with this disease in pigs, vermicides such as piperazine products, oil of chenopodium, male fern, or santonin should be given, followed by an oily purgative. To clear out ascarids give phenothiazine in 5-gramme capsules for pigs under 25 lb. weight (20 grammes for pigs of 200 lb weight).

Suppurative Hepatitis.—Occasionally hydatid cysts in the liver become suppurative and pyogenic organisms may invade the organ from an outside source, as is the case in traumatic peritonitis. It sometimes happens that a pig may swallow a piece of cane from a broom-head, or a sewing-needle, etc., and these eventually find their way into the liver substance, resulting in the formation of an abscess In other cases the foreign body may be completely embedded in the liver, with no trace of abscess formation One can understand how a pig may obtain access to a broom-head, but sewing-needles are somewhat of a mystery, as one does not usually associate the use of the household sewing-needle with pigs, unless unqualified castrators are in the habit of using such needles and occasionally losing them in

the pig pens during the spaying operation. The writer has quite a collection of such needles recovered from pig livers. The symptoms are not usually noticed during the animal's life, and it is only at a post-mortem examination that the condition is found.

Gall-stones.—In the pig's gall-bladder the concretions found are hard and egg-shaped, usually completely filling the gall-bladder; they are very rare, and may start from bile salts deposited around a parasite or some epithelium. They may give rise to symptoms of jaundice or biliary congestion, but their presence is not usually diagnosed during life.

Peritonitis.—This condition may be acute or chronic, local or general, traumatic or idiopathic, and is due to the invasion of the peritoneum by various micro-organisms. It may occur in the pig as an extension from a bad case of pleurisy or pleural empyema, in which case it is often a local condition, the peritoneal surface of the liver and adjoining diaphragm being affected. It may also occur from the invasion of a castration or spaying wound by pyogenic organisms, or from some injury to the abdominal wall. There is also a tuberculous peritonitis in pigs as in other animals, and parasites may occasionally invade the peritoneal cavity, setting up an acute inflammation.

Symptoms.—There may be visible evidence of infection of a castration or spaying wound, etc.; the condition is usually very painful, with a loss of appetite, some constipation, and a high temperature. The respirations are mainly thoracic and are increased in frequency. The animal may lie down on its side in a prostrate condition. Pain is evidenced when the abdominal wall is pressed.

Treatment.—Sulphonamides and penicillin may be successful in controlling the infection in some cases. Operation wounds should be thoroughly cleaned out and antiseptic treatment applied. A warm enema may be given to assist in the removal of fæces. Quinine, salicylates and potassium iodide may be prescribed, with an injection intramuscularly of camphor in an oily base in cases where there is danger of collapse from heart failure. In young pigs treatment with sulphonamides may give good results, with some warmth applied to the abdomen.

Ascites.—Dropsy of the peritoneum occurs in certain liver diseases, following liver fluke infestation, lung disease, anæmia,

heart and kidney diseases, and interference with the circulation in the splanchnic area. The peritoneal cavity may contain some clear, colourless or straw-coloured fluid.

Symptoms.—This condition may not be noticed until a considerable quantity of fluid has accumulated in the abdomen, when the belly becomes swollen and pendulous. There may be some emaciation, but the condition is not characterized by any painful symptoms, except that in advanced cases breathing may become laboured.

FIG. 75.—PIG SPLEEN SHOWING OMENTAL STRANGULATION.

Treatment.—Affected animals are best slaughtered, as curative treatment in the pig is not satisfactory.

Splenic Congestion.—Congestion of the spleen in the pig may be found associated with certain specific fevers, but there is also a physiological congestion often found during post-mortem examinations on pigs, and especially marked in the comparatively large spleen of adult pigs and sows. This physiological congestion may become chronic and pathological, with the formation of some excess fibrous tissue in the organ. An acute congestion of the spleen may lead to rupture of the organ in some cases, and then to internal hæmorrhage and death. The condition is not usually diagnosed clinically, and is only discovered at a post-mortem examination.

Atrophy of the Spleen.—Atrophy of the spleen is sometimes encountered also at post-mortem examinations on pigs. In such cases the spleen tissue may be a mere trace attached to the omentum, whilst the general carcase condition may be quite good.

Strangulation of the Spleen.—The spleen in the pig is firmly attached on one side to the omentum, which is in the form of a network of fat. Occasionally a loop of the omentum may be found surrounding the spleen towards its middle and strangulating the organ, so as to cause a complete atrophy of one-half of the spleen. The remaining portion of the spleen may assume comparatively large proportions, a compensating hypertrophy, and may be completely altered in shape.

Other conditions found in the spleen are tuberculous nodules, lymphadenomata, or tumour-like formations seen very rarely in pigs, usually when the animal is affected with leucocythæmia. Hydatid cysts are also encountered in the spleen substance.

None of these conditions are diagnosed during life, and unless associated with some specific disease they do not appear to cause much ill-effect to the pigs.

Pancreatic Diseases.—Occasionally the pancreatic ducts are invaded by ascarids from the intestines, and there is also found in pigs a form of pancreatic degeneration in which the normal pancreatic tissue is replaced by a pale-greenish mucoid substance, whilst a form of fat necrosis is also found on rare occasions. No clinical symptoms of these conditions have been noticed, and the lesions are generally found at the post-mortem examination of pigs.

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Chapter 11

MISCELLANEOUS CONDITIONS—*Continued*

The Urine of Pigs.—Pig's urine has a specific gravity of between 1·018 and 1·022, or an average of 1·020. The quantity voided daily varies according to the size of the animal, and is said to be from 2 to $2\frac{2}{3}$ pints, or $2\frac{1}{2}$ to 3 lb. (from 2 to 4 litres, with a maximum of 6 litres). The quantity of solid excrement voided daily is said to be about 1 lb.

APPROXIMATE COMPOSITION OF SOLID EXCREMENT

Water	80	per cent.
Organic matter	16·5	,,
Minerals	3·5	,,

APPROXIMATE COMPOSITION OF URINE

Water	97	per cent.
Organic matter (urea, uric acid, etc.)	2	,,
Inorganic matter (salts of potash, soda, phosphorus, etc.)	1	,,

The composition of the urine will vary according to the nature of the food consumed, the age of the animal, and the amount of exercise allowed. The specific gravity is raised by any hæmorrhage into the urinary tract, and in albuminuria, diabetes mellitus, and certain febrile conditions, whilst the colour is affected by the condition of the liver and intestines, the amount of solid excrement passed, and by the administration of certain drugs. The odour of the urine is also affected by drugs, as well as by foods and bacterial flora. The reaction of normal pig urine is acid when suckling and alkaline when on a herbivorous diet. The colour is normally a light-straw, and the odour is characteristic.

Albuminuria.—Albumin is not normally present in urine, and its presence indicates some disease of the urinary tract, kidneys or bladder, or some poisoning such as poisoning by carbon dioxide, lead, phosphorus, mercury or arsenic. It may also be present in the urine in tetanus and in the deficiency

diseases. When the albumin is due to some disease of the urinary tract it may be present in the form of blood, epithelium, serum albumin or serum globulin, and may occur as casts of the uriniferous tubules of the kidneys.

As the condition is associated with some pathological condition in the body, treatment would have to be directed towards a removal of the cause, and this is most frequently found in dietetic deficiencies in pigs.

A chronic form occurs in chronic interstitial nephritis, often encountered in sows and adult pigs. There is usually some emaciation of the carcase in such cases.

Hæmaturia.—In this condition blood is found in the urine due to some hæmorrhage along the urinary tract, the kidneys, bladder, or urethra. If the kidney tubules are affected there may be microscopic casts in the urine. When the bladder is affected the blood may be in the form of clots passed towards the end of the process of urination. Some ingredients in the food may also be responsible for a red-coloured urine.

Treatment will depend upon the diagnosis of some disease along the urinary tract, and hæmatinics are useful to compensate for the loss of blood. Internal styptics, sandalwood oil, hexamine, sodium salicylate and halibut-liver oil are all useful. (See Cystitis.)

Hæmoglobinuria.—This condition is distinguished from hæmaturia in that it is only the colouring matter of the blood that is found in the urine and not the blood corpuscles themselves. This condition may be found accompanying some specific disease, or may be due to a protozoan blood parasite.

Treatment should be directed towards the cause of the condition.

Ropy or Stringy Urine.—This may be due to the presence of mucus in the form of fibrinous flakes. In cystitis the urine may be oily and give off a very offensive odour. Again these are only symptoms of disease elsewhere in the body.

Congestion of the Kidneys.—Active congestion of the kidneys is due to an increase in the flow of blood to the kidneys, with a consequent increase in the urine. The condition may be set up as a result of various specific diseases, bad food, certain drugs—*i.e.* diuretics. The condition may also be the result of some nervous excitement or of some injury to the

loin region. Unless the condition is attended to it may eventually lead to nephritis.

Symptoms.—Urine is passed in increased quantities, and is of a reduced specific gravity and light in colour. There may be some tenderness over the loins and stiffness in the hindquarters. In mild cases no blood is passed in the urine, but there is some hæmaturia in severe cases.

Treatment.—The animal should be placed in a warm pen and given a good purgative. Excessively sloppy food should be avoided and some powders composed of sodium sulphate and magnesium sulphate with some potassium iodide given. The animal should be protected from any draughts.

Venous Congestion of the Kidneys.—In this condition there is some stasis or diminution of the blood passing out of the kidneys, resulting in the congested state of the organ. This condition may be caused by valvular disease of the heart causing interference with the circulation, especially that of the venous blood. Any form of pressure on the renal veins will also cause venous congestion.

Symptoms.—Following some increase in the urine passed there is later a decrease with some hæmaturia and albuminuria. There is tenderness and pain over the loin region and some disinclination to move the hind-legs.

A post-mortem examination reveals a very dark-coloured kidney, often considerably enlarged, and containing an abnormal amount of blood.

Treatment consists in providing the pig with a warm pen free from draughts, and giving a saline purgative such as sodium or magnesium sulphate with some iodides in the food.

Nephritis.—Nephritis, or inflammation of the kidney, may take the form of an *interstitial nephritis* affecting the intertubular connective tissue, a *suppurative nephritis* in which there is pus formation in the kidney, or a *parenchymatous nephritis* affecting the Malpighian bodies and tubules. All three forms are found in pigs, especially in adult sows, but few of these conditions are ever clinically diagnosed. The cause is believed to be the passage of irritant substances through the kidneys, either from the food or from a bacterial invasion of the organ. Cold or a direct draught on to the animal's back is said to be a factor also.

Interstitial Nephritis.—This form of nephritis may come on after an attack of acute nephritis or following some congestion of the kidney. Both kidneys may be affected, and there are few symptoms beyond frequent micturition, the urine being albuminous and forming a froth on the ground. The animal may later show some signs of general unthriftiness, although the diet may be good. There may be marked thirst, and some ascites in old-standing cases.

In *acute nephritis* epithelial cells may be present in the urine, and these can be recognized microscopically and also serve as an aid in estimating the seat of trouble. The pelvic epithelium being squamous, the glomerular capsules are flattened, the convoluted tubules are spheroidal, and Henle's tubes are rodded in shape. In the *suppurative* form there may be some pyæmic condition present in the body to account for the organisms carried to the kidneys.

Symptoms.—In the early stages the symptoms of acute nephritis are similar to those of congestion of the kidney. Later the urine becomes reduced in quantity and somewhat turbid, containing many casts, and there is some hæmaturia. The animal's back may be slightly arched and there is some flinching when the loins are pressed, with some apparent difficulty in moving the hindquarters. The temperature may be raised a few degrees and there will be some accelerated respirations, and the skin may show urticarial lesions.

Post mortem.—A post-mortem examination of a nephritic case will reveal some of the various forms of the condition, but the interstitial form appears to be more often encountered in old sows. Both kidneys are affected at the same time, or only one, and may show extensive pale areas of fibrous tissue, the kidney outline being very irregular and the surface scarified. If one kidney only is affected, it often happens that there is a compensating hypertrophy of the other kidney. The carcase in such cases may not be emaciated, but where both kidneys are badly affected there is usually an emaciation of the carcase as well as a uræmia, the latter being most pronounced.

Treatment.—These conditions in pigs, although often found during post-mortem examinations, are seldom clinically diagnosed, as they usually occur in old sows that are "not doing too well," and the owner prefers to try and fatten them

very doubtful whether that is the real cause, as such foods are often fed to pigs, yet renal calculus is a very rare condition in those animals. Renal calculi are not diagnosed clinically in pigs unless they lead to acute nephritis in some old animals.

Cystic Calculi or Gravel.—Stones in the urinary bladder are also rare in pigs, but one may sometimes find sabulous material (gravel) which may completely fill the bladder. This is composed of the triple phosphate of calcium, magnesium and ammonia. This gravel causes some interference with urination when present in large quantities, whilst the urine may become very turbid.

FIG. 76.—HYDRONEPHROSIS OF THE PIG'S KIDNEY (LEFT): NORMAL KIDNEY (RIGHT).

Urinary calculi may be caused by infections, faulty diet, drinking of saline waters over a long period, leading to physiochemical disturbance in the urinary tract. The triple phosphates and calcium carbonate are found in alkaline urine, whilst acid urine may contain calcium oxalate as well as silicates.

Symptoms.—Affected animals become very restless. There is a partial or complete stoppage of the urinary tract, with anorexia, arched back, and straining to urinate. A little urine containing blood or pus may be passed. The animal lies on its belly, and as the condition progresses rupture of the bladder may occur. The temperature drops to subnormal, uræmic poisoning sets in and death results.

Treatment.—The alkaline urine should be rendered acid by small daily doses of gluconic acid, or acid sodium phosphate and calcium or ammonium chloride, to help dissolve the calculi. Magnesium salts, potassium citrate and alkaline carbonates

render the urine alkaline. Glycerin is believed to act favourably through its spasmolytic action and by increasing peristalsis of the ureters.

Irrigation by means of a catheter and some sterile salt solution may be useful, but often the condition is not suspected until the bladder is almost full of gravel, so much so that the organ cannot hold much fluid, and the animal may suffer from *incontinence of urine.* As the condition is usually found in adult sows, it is often best to fatten them up for slaughter rather than attempt treatment.

Incontinence of Urine.—This condition, as already mentioned, may be due to the presence of calculi or gravel in the bladder. It is a condition in which the animal is unable to retain its urine, and, apart from the presence of a calculus, it may be caused by nervousness, fright, paralysis of the sphincter muscle of the bladder, injury to the loins, or the presence of tumours in the bladder.

The *symptoms* are a constant dribbling of urine, giving the animal a strong urinous odour, and causing some excoriation of the skin between the hind-legs.

Treatment consists of removal of the cause of the condition, in the case of cystic calculi and gravel, by irrigation of the bladder. Good foods, tonics, halibut- or cod-liver oil should be given so as to build up the animal's vitality generally.

Retention of Urine.—This condition is the opposite of incontinence, and the animal appears unable to pass any urine at all. This may be due to calculi becoming fixed in the neck of the bladder or urethra, some tumour pressing on the urethra, paralysis of the muscles of the bladder walls, or an injury to the spine.

The *symptoms* are a complete cessation of the passage of urine, with evidence of great pain, and attempts at micturition. There may also be some constipation, restlessness, and evidence of abdominal pain.

Treatment in the sow consists in passing the catheter and removing the urine by that means. In small pigs and adult boars the condition, fortunately very rare, may necessitate the immediate slaughter of the animal. Bladder puncture by trocar and cannula gives temporary relief in a small pig, and prevents a urinous carcase odour after slaughter.

Uræmia:—This arises when poisonous waste products which should normally be passed out of the body via the urine are retained in the blood. Uræmia is found in advanced nephritis, tuberculosis, tumours, abscesses in the urinary passages, Bright's disease, or the blocking up of the urine excreting mechanism.

Acute uræmia in baby pigs produces symptoms resembling those of hypoglycæmia, but analyses of the food, water, and tissues of affected animals have failed to indicate any toxic cause in such cases.

Symptoms.—Pigs show symptoms within one to three days of birth in piglet uræmia. They appear unthrifty, with a rough, staring coat. Temperature later drops to subnormal. Young pigs are hypersensitive, isolate themselves, squeal and have tremors when disturbed. Diarrhœa is present. Death occurs in about nine days from the onset of symptoms and is preceded by convulsions.

Post mortem.—The constant finding in piglet uræmia is of a precipitate impacted in the papillary ducts of the kidney, or lying free in the renal pelvis, ureters or bladder. These uric acid infarcts are orange coloured, or almost white, and consist largely of uric acid or urates. Blood urea and uric acid show large increases above normal level. The kidneys are pale and the capsule peels easily. An accumulation of precipitate can sometimes be seen on close examination on the surface of the kidney, even through the capsule. Pressure will cause the precipitate to flow in the ureter.

Treatment.—In adult pigs uræmia is a complication of some other disease, and treatment should be directed towards eradication or cure of the cause. Prognosis is not very favourable, as when uræmia sets in the condition of the animal is generally very serious.

The acute uræmia of piglets in America is said to be due to lack of a relatively high fluid intake early in life, so as to stimulate renal activity. Complete or partial starvation will produce a condition similar to that found in the young pigs. Treatment and prevention therefore lie in stimulating a good milk flow from the dam's udder when the pigs are born.

Paralysis of the Bladder.—This is nervous in origin, or due

to some spinal injury. A calculus fixed in the urethra may prevent the passage of fluid, and so cause great distension of the bladder with paralysis of the walls and retention of urine. In other cases the paralysis only involves the sphincter muscle and causes incontinence. The symptoms are those either of retention or incontinence. The catheter may give relief, and the water supply is withheld in case of retention in adult sows. Tonics, vitamins and good food should be prescribed, with massage along the loins.

Cystitis.—Inflammation of the bladder may be due to a bacterial infection, or to irritants in the urine. Conditions causing retention of urine may result in the deposition of salts in the bladder with irritation of the bladder wall, setting up inflammation. Pyæmia leads to abscess formation in the bladder, and to a suppurative cystitis. A diphtheritic cystitis is also encountered in some specific acute septicæmias like swine fever.

There is an infectious cystitis and pyelonephritis affecting sows and boars, where hæmaturia is a symptom. It affects sows within a month of service, when they show a vaginal discharge as well as blood-stained turbid urine. Among the organisms isolated from sediments in affected urine is a slender Gram-positive rod for which the name *Corynebacterium suis* is suggested. Post-mortem examination shows a cystitis with an inflammation extending to the ureters, leading to a pyelonephritis, with œdema. In sows the urethra and vagina show inflammatory lesions.

Symptoms.—There are painful attempts at urination, with the passage of small quantities of urine, and some hæmaturia. Pus may also be found in the urine in the suppurative type. Disinclination to defæcate leads to constipation. Urine passed shows albuminuria, blood clots, and portions of epithelial cells.

Treatment.—This condition is most frequently found during some systemic fever. In sows it may be possible to irrigate the bladder with a warm saline solution or mild solution of boracic acid or chinosol. Internal treatment consists of the administration of antibiotics, urinary antiseptics, and enemata *per rectum* to facilitate the passage of fæces. The animal should be kept in a warm, draught-free pen, and the

stricted, but with a plentiful supply of water, if there etention of urine.

thritis.—An inflammation of the urethra may be in the of an extension from a cystitis, or it may be caused by sence of a small urethral calculus or irritant matter.

ıptoms.—Pain during the act of micturition, and evi- of apparent sexual excitement. The sheath in the male e vulva in the female may be enlarged and inflamed.

atment consists in the washing out of the urethra with antiseptic solution such as boracic acid or chinosol, ne administration of urinary antiseptics internally—*e.g.* ine, sandalwood oil. Plenty of drinking water should be ed so as to prevent the urine from becoming too concen- and irritating to the inflamed urethra.

ethral Calculi.—These are very rarely found in pigs; re usually derived from the bladder, and may consist of sabulous material or gravel passed out with the urine he urethra. In adult male pigs the gravel may be ed at the S curve of the penis or near its extremity. ifficulty in passing urine may lead to some retention and tended bladder. Where the condition causes serious ıction in the boar it is best to slaughter the animal than attempt surgical treatment.

ostatitis.—Inflammation of the prostate gland is some- found in old boars. A chronic form may be encountered ıich the prostate is considerably enlarged, or an acute may be seen, often of a suppurative nature, and usually dary to some pyogenic infection elsewhere in the body.

ımptoms.—There is frequency in micturition, later some tion of urine if the gland is so enlarged as to cause some ure to be exerted on the urethra. The condition in boars usually noticed until the animal is slaughtered, and such als are fattened up for slaughter because they are either too r have been found useless as stock-getters.

letritis.—Inflammation of the uterus sometimes occurs in following the farrowing of dead and putrefying pigs. e is generally a history of some difficulty in farrowing, the little pigs having to be brought away by the forceps y hand. Some whitish discharge from the vulva may be ed about twelve hours before farrowing. The condition

may follow contagious abortion, or be the result of some injury to the uterus during pregnancy, resulting in the early death of the fœtuses. After farrowing the lining of the vagina and uterus may be inflamed and shreds of the mucous membrane may be shed. Penicillin treatment gives good results. The uterus should be irrigated with a mild astringent and antiseptic solution, and drugs of the sulphonamide group administered. In practice it has been found advisable not to risk another service and to eliminate such sows from the herd.

FIG. 77.—*Esch. coli* MASTITIS.

Vulvovaginitis.—This condition of inflammation of the vagina and vulva in pigs has been described by American and Australian veterinary surgeons. Animals affected are female pigs of all ages, and even suckers, and whilst the exact ætiology of the condition is by no means certain, it would appear that the condition is not contagious and can be produced as a result of feeding on mouldy maize. McNutt, Purwin and Murray in Iowa were able to produce the condition in pigs by feeding on damaged corn, and an outbreak in Victoria was described by Murray, Pullar and Lerew.

Symptoms.—Great enlargement of the vulva, with some œdema of the labia and congestion of the mucosa. Some

catarrhal exudate may be found in the lumen of the vulva and vagina, with a discharge through the vulva. The pigs affected become unthrifty and emaciated, whilst prolapse of the rectum and of the vagina may occur in some cases.

Treatment.—Examination of smears from the exudate shows numerous leucocytes, epithelial debris, and a mixed flora of Gram negative and positive cocci and a short Gram negative bacillus. The mortality rate in the American outbreak appears to have been high, and in from 5 to 10 per cent. of the cases prolapse of the rectum was found, but prolapse of the vagina occurred in as many as 30 per cent. The condition ceases on discontinuing the feeding of the offending mouldy maize, and it would appear that the irritant substance is either present in the fungus or is a product of its metabolism, and has a special effect on the mucosa of the vagina and vulva in females, but does not appear to affect male animals.

Mastitis.—In recent years inflammation of the mammary gland in both gilts and sows has become a widely recognized syndrome especially in animals housed in damp and draughty buildings. The incidence is highest in unduly fat sows. The condition is most commonly due to infection with *Esch. coli* which is responsible for the acute signs of disease. While the same organism can be associated with the chronic form the latter is more often due to actinomycosis. One or more mammæ may be affected and the severity of signs varies. Onset is generally immediately after farrowing, but may be delayed for 2 or 3 days or even longer until trauma from the piglets' teeth predisposes to the development of mastitis. The condition must be differentiated from agalactia from other causes.

Symptoms.—In acute cases the sow is dull, cold, and shows complete anorexia. The elevation in temperature is not so marked as in puerperal fever. The sow is reluctant to rise and does so with difficulty. A state of toxæmia soon renders the animal comatose and death may occur in about 3-4 days. The affected mammæ are very swollen, hot and painful, and the overlying skin is erythematous. Less acute cases show milder systemic signs and the mammary lesion is harder. The chronic form may develop from the acute or be present from the outset. It takes the form of varying-sized induration of the affected

gland, some of the lesions weighing 25 to 30 pounds in weight. Necrosis of central tissue usually follows with the production of discharging sinuses to the surface. Concurrent mastitis with purulent uterine discharge is sometimes present.

Treatment.—Streptomycin in daily 1 gm. doses should be given for 3 days. Penicillin or the chemotherapeutic drugs may also be given if other sensitive organisms are thought likely to be present. Some people advise the use, in addition, of *E. coli* antiserum. The general comfort and feeding of the patient should be attended to. The chronic induration of the actinomycotic udder could only be treated by heroic surgery.

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Chapter 12

MISCELLANEOUS CONDITIONS—*Continued*

Bronchitis and Tracheitis.—Inflammation of the trachea and of the bronchi in pigs may occur as an extension pneumonia or from some inflammatory condition of the larynx, pharynx or nasal cavities. It may also be set up by parasitic worm infection of the tubes, inhalation of irritant gases, and careless drenching with medicines. The condition may be either acute or chronic.

Symptoms.—The respiratory sounds are harsh and pronounced, with fits of coughing, especially after exertion. There may be some nasal catarrh with an accompanying discharge, as well as a discharge from the eyes. The temperature may be elevated in acute cases, but in the chronic stage the symptoms are not so distinct, but there may be a gradual wasting and unthriftiness.

Treatment.—As a rule the condition is secondary to pneumonia in the pig, or to an infection with strongyles. In the former case the treatment is similar to that prescribed for pneumonia—viz., sulphonamides, isolation in a clean pen with adequate ventilation. Where worm parasites are suspected as the cause, cyanacethydrazide preparations are prescribed, together with a balanced ration containing minerals and vitamins. Drenching with liquid medicaments should be avoided. Electuaries or stomach tubes should be used.

Congestion of the Lungs.—An abnormal amount of blood may be present in the lungs in the early stages of pneumonia. Anything causing an increasing flow of blood into the lungs without a corresponding outflow will produce a congestion, as will any interference with the outflow. An active hyperæmia is found in the pig in the first stage of pneumonia, and it may be due to bacterial invasion, exposure to draughts or faulty ventilation in the pens, a badly balanced food, and lowered vitality enabling organisms to invade the lung tissues and set up pneumonic lesions. The inhalation of irritant gases will

also set up an active hyperæmia, as will irritation from worm parasites. A passive hyperæmia is usually due to some valvular diseases of the heart, as in some cases of swine erysipelas, and this impaired action of the heart causes an accumulation of blood in the pulmonary circulation, which eventually may lead to changes in the lung tissue. Such changes are slowly formed; the lungs are dark red in colour, somewhat firmer than normal, and pieces of lung tissue will sink in water.

Symptoms.—The animal may be found lying down, with respirations very accelerated and pronounced. The temperature may be raised some degrees. There may be a watery discharge from the nose, and in later stages some discoloration of the ears.

Treatment.—As this condition is so frequently the forerunner of pneumonia in the pig, administration of sulphonamides in the early stages will prevent the progress of the infection. If the pig is caught, an injection given, and the animal removed from any draughts, the sulphonamide treatment is most effective. In the early stage one or two doses of sulphadimidine may be enough, or the dose may be repeated once every four hours, with penicillin injections.

Pulmonary Œdema.—The presence of serous fluid may be detected in the lungs in cases of pneumonia, in anæmia, and in acute endocarditis. The lungs do not collapse, but appear swollen with fluid.

Symptoms.—These are similar to those shown in acute congestion and in pneumonia, and develop rapidly, causing a good deal of blowing and great distress, with a discharge of frothy material from the nose and mouth. The condition terminates fatally in most cases, because the lungs will be so full of œdematous liquid as to render an exchange of oxygen for CO_2 impossible, and the pig becomes suffocated. The emergency slaughter of the animal in an endeavour to salvage the carcase is advisable where this condition is diagnosed.

Pleurisy.—Pleuritis, or inflammation of the pleura, often accompanies pneumonia in the pig, where it is secondary to that condition. There is also a primary pleurisy found associated with infection of the pleural cavity by microorganisms. A chest wound or injury to the pleura from a fractured rib may also set up a secondary pleurisy, whilst

the condition is found in pyæmic infections and in tuberculosis. The organisms usually associated with pleural infections are members of the Pasteurella group, staphylococci, streptococci and the tubercle bacillus. Cold is said to be a predisposing cause of pleurisy, as it is of so many inflammatory conditions. As in pneumonia, exposure to draughts undoubtedly seems to lower the vitality of the part in some way and pave the way for bacterial infection.

The changes taking place in the pleura are first a blood congestion and a drying up of the pleural surface, followed by a thickening of the membrane and exudation into the pleural sac. The exudate varies in amount and character according to the extent of the disease. In acute cases the exudate may be copious and rich in fibrin, coagulating on the pleura in the form of a yellow film, whilst shreds of a similar material may be found free in the fluid exudate. This type of *serofibrinous pleurisy* is often seen in the pig. Another type is *purulent pleurisy*, in which the exudate contains pus, and there may be a condition of *pleural empyema*, in which one or even both lungs may be involved, a portion of the lung itself becoming converted into a large abscess and the chest cavity full of purulent, stinking matter. A *chronic pleurisy* is also commonly found in the pig, in which the pleural effusion has been absorbed, leaving some adhesions between the lungs and the chest wall. Extensive areas of the lung may thus be found adhering to the chest wall. Pleurisy in the pig may be either unilateral or bilateral, and a tuberculous pleurisy is not uncommon.

Symptoms.—Owing to the fact that pigs are usually deprived of any exercise, the symptoms of pleurisy are not so apparent as they are in animals at exercise and work. The symptoms are very similar to those of pneumonia, the patient lying down and being disinclined to move. Temperature is elevated, and there may be some coughing, and a slight discharge from the nose and eyes. Respirations are abdominal and much accelerated. There may be some discoloration of the ears, as in pneumonia, and in most cases a pneumonia accompanies the pleurisy. The pericardium is often involved as well. The animal, if walked a short distance, will lie down exhausted, breathing through the mouth. Owing to the frequency with which the disease involves the pericardium and lung substance

in the pig, death often occurs from cardiac failure. In other cases resolution takes place, and a form of chronic pleurisy is left with some adhesions between the lung and chest wall.

Treatment.—The animal should be placed in good hygienic surroundings and the chest and back covered with some sacking or a rug. Medicinal treatment is the same as for pneumonia in the pig, and all liquid drenching should be avoided. Tapping of the chest to release fluid is not usually considered worth attempting in the pig, as treatment with sulphadimidine will often bring about sufficient improvement to enable the animal to be fattened up for slaughter.

Pericarditis.—Inflammation of the pericardium in the pig is usually idiopathic and may be secondary to an attack of pleurisy. Traumatic pericarditis is not often found in pigs. In this condition the pericardium may be thickened and the pericardial sac may contain an excessive amount of fluid (pericardial dropsy). Adhesions may form between the heart and pericardium, and between the latter and the lung pleura. The condition may also involve the heart muscle, causing a myocarditis.

Symptoms.—There is usually some listlessness and disinclination to move about. On being walked some little distance the pig will lie down panting, breathing through the mouth, and exhibiting symptoms similar to those of pleurisy. Both pleurisy and pericarditis are so frequently associated in the pigs that it is rare to find an uncomplicated case of pericarditis. On auscultation the heart sounds may be found to be intensified, whilst there may also be some congestion of the skin.

Treatment.—As pericarditis in the pig is so often secondary to pleurisy, the treatment follows the same lines as that prescribed for the latter condition. Any tendency to anæmia should be treated by iron and copper salts, halibut-liver oil, etc., and the animal fattened for slaughter.

Myocarditis.—Inflammation of the heart muscle may be secondary to a case of acute pericarditis, or may occur in an acute septicæmia such as swine fever, acute swine erysipelas, paratyphoid, in certain poisonings, and as a result of irritation set up by parasitic cysts. Fat pigs dying in transit to abattoirs often show some hæmorrhages and degenerative changes in

the heart muscle. Acute myocarditis is usually secondary to a systemic infection, or to an attack of pleurisy with pericarditis.

Symptoms.—Very few symptoms may be exhibited, and the animal may collapse and die suddenly. In chronic cases, due to some parasites such as *Trichina spiralis*, sarcocysts, or the *Echinococcus veterinorum*, there may be some disinclination to walk any distance, as in pericarditis and pleurisy, the animal lagging behind the others, lying down, panting and refusing to get up, but the symptoms are not diagnostic of

FIG. 78.—PART OF PIG'S HEART EXPOSED TO SHOW ENDOCARDITIS LESION ON THE MITRAL VALVE.

myocarditis. For this reason treatment is seldom resorted to, and the animal is usually slaughtered.

Endocarditis.—Inflammation of the endocardium is usually associated with swine erysipelas and staphylococcal infection in the pig. Hydatid cysts may also set up an irritation on the endocardium. The lesions are usually found on the valves on the left side of the heart in the form of warty-looking growths or vegetations. In the early stages the growths are as little blebs or tiny cysts filled with blood; these grow in size and burst, leaving a rough surface on which the wart-

like growths appear. These may be so large as almost completely to fill the left auricle. The vegetations can be easily broken off, and will result in the formation of emboli. The chordæ tendineæ may be involved as well as the valves, and there is some hypertrophy of the heart. The presence of these growths results in incompetence of the auriculo-ventricular valves, and produces a *murmur* (after the normal valve sound) due to the regurgitation of blood. In stenosis, where the valve opening is narrowed, the murmur usually appears before the valvular sound.

It is the mitral valve that is most often found affected with endocarditis lesions in the pig, and the lesions are such as to produce incompetence rather than mitral stenosis. The effect of this is to produce a pulmonary stasis, with a rise of blood pressure on the right side of the heart and dilatation of the right ventricle, with some œdema. Owing to the subcutaneous fat, the jugular pulse which accompanies the condition cannot be seen in the pig.

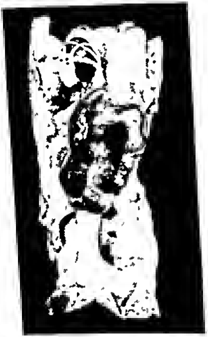

FIG. 79.—PORTION OF PIG'S HEART SHOWING INFLAMMATORY GROWTH ON ONE OF THE CHORDÆ TENDINEÆ.

Some congestion of the skin and the characteristic swine erysipelas skin lesions may be found accompanying the endocarditis.

As most pigs are deprived of exercise, the condition persists without any great danger to the pig until the animal has been fattened up to slaughter weight, and for that reason treatment usually consists of the use of pencillin, sera, and vaccines against swine erysipelas rather than any direct attempt to cure the heart lesion itself.

Fatty Degeneration of the Heart.—This condition is also one encountered at post-mortem examinations on pigs. It may be found in acute cases of pleurisy and pneumonia,

septicæmic diseases, and in certain metallic poisonings. Pigs dying during transit to a slaughter-house will often show this condition of the heart muscle. The muscle is paler than normal, and may be yellowish-red in colour and easily torn. A *fatty infiltration* may also be found in fat pigs. The fat in the heart furrows is increased and may spread all over the heart. This may lead to:

Heart Failure, or Syncope.—The cause of ordinary heart failure is believed to be due to the limited exercise, lack of sunlight and fresh air, under intensive feeding methods. The condition is seen after pigs are transported, and especially if they have been fed shortly before being loaded. A mechanical pressure of an overloaded stomach on the diaphragm hampers breathing, and reflex disturbances may have a great significance, as the parasympathetic fibres of the vagus nerve may have a vasoconstrictor effect on the coronary circulation, and a congestion or œdema of the lungs may follow.

Mulberry Heart (Herztod).—Vogt reports that this condition of Herztod or mulberry heart may be due to the excessive feeding of carbohydrates and to avitaminosis, the complaint occurring when the protein-starch ratio is in the region of 1 : 12·5. The presence of trace elements in an unbalanced ration is also thought to be a factor. He rules out nutritional causes, and suggests that management was too intensive, this giving rise to the theory that the condition is possibly hereditary.

Symptoms.—The pig shows sudden tremblings, staggering and squealing, with frothing at the mouth and nose, a slow short breath, collapse and death.

In respect of mulberry heart, Wood suggests there is no particular age incidence, the pig is reported to be off its food. Body condition is good. When the animal is moved it stops and shivering occurs over the fore and hind quarters. The forelegs are abducted and the nose pushed to the ground to afford support. When pushed over the pig falls rigidly on its side with much squealing. Lifted by its tail it adopts a dog-sitting position. Cyanosis of skin areas is absent, and temperature may be subnormal. Fæces are normal or the animal appears constipated.

Post mortem.—Pericardial dropsy with epicardial hæmor-

rhages, discrete or in striations over the atria in particular. The pronounced lung œdema and distension of the interlobular septa have led to suggestions that this condition may be linked with bowel œdema in some cases.

Treatment.—As the condition is so often fatal, slaughter of the affected animal and carcass salvage may be advisable. High protein diet, avitaminosis (E), overfeeding resulting in partly digested food in the small intestine providing opportunity for growth and toxin production by non-invasive serotypes of hæmolytic *Esch. coli*, as in œdema disease, have all been suggested as causes. Prevention by the provision of a less highly nutritious diet in the young pig is indicated.

Diaphragmatic Rupture.—Rupture of the diaphragm is occasionally encountered in pigs, generally in young animals, and is often due to the little pigs squeezing under a low fence or gateway. Owing to the fact that pigs are deprived of exercise for fattening purposes, the symptoms of diaphragmatic rupture may be very slight, and beyond some vomiting, which may easily be mistaken for a symptom of worm infection, they may pass unnoticed until the pig is slaughtered. The pig may appear very distressed, sitting on the haunches, and with blowing respirations and vomition. The symptoms may disappear for a time, and may reappear some time after feeding. They gradually become less pronounced as the internal organs adapt themselves to their changed positions. Cases have been found at a post-mortem examination in which some of the abdominal organs were found partly in the chest cavity, the edges of the rupture being quite smooth, showing signs of having been of long standing. A lobe of the liver may be found in the chest cavity or portion of the small intestine, and the condition would not appear to have caused the pig much harm, judging by carcase condition. There is always a danger in such cases of a portion of the bowel becoming strangulated, or pressure on the heart and lungs causing sudden death, and where such a condition is suspected immediate slaughter is advisable, unless the owner is prepared to take a risk and fatten the animal up to pork weight.

Aneurysm.—An aneurysm is formed by the gradual dilatation of an artery, and in old cases the normal wall of the artery

atrophies and the cavity is surrounded by layers of connective tissue. A false aneurysm may arise from the rupture of an artery and the formation of a sac containing blood lined by the surrounding connective tissue. Pressure of blood on a weakened arterial wall may cause an aneurysm, and this may arise from traumatism, embolism, atheroma, or from a parasitic invasion of the arterial wall. Aneurysms may cause death from rupture of the artery wall, leading to internal hæmorrhage, or the contents of an aneurysm may break away and form emboli. Thrombosis with complete stoppage of the circulation through the affected vessels may also occur.

Arteritis, or inflammation of an artery, may occur as a result of some injury or infection. *Hypertrophy* of arteries may also occur when there is some resistance to the circulation, whilst *degenerations*, such as fatty degeneration, may follow certain acute systemic diseases.

Arteriosclerosis consists in a hardening of the walls of an artery due to thickening and fibrosis. *Atheroma* consists of a local thickening accompanied by degenerative changes in an artery, and is most often found affecting the aorta.

Lesions similar to those of *atherosclerosis* in man can be found in the pig, particularly in the internal lining of the aortic arch. The intima of the porcine aorta is similar to that in man. A thin layer of connective tissue cells separates the endothelial lining from the media. With advancing age a gradual diffuse thickening of the endothelial connective tissue is observed. There are two types of lesions, the fibrotic and the calcified. The fibrotic can be differentiated further by the presence or absence of stainable lipoid materials. Gottlieb and Lalich found that visible lesions vary from small pale-yellow elongated plaques (0·5 mm. to 1·5 mm.), hard to the touch under the endothelium, to larger thickened parts of the intima (5 to 10 mm. long). The small lesions are generally nearly parallel to the long line of the aortal axis. Most of the plaques are seen in the descending arch in the upper thoracic region. The age incidence is increased from 3 per cent. in six-month-old baconers, to 35 per cent. in adult sows over three years old. Typical lesions can be found in the course of post-mortem meat inspection, by slitting open the aorta, particularly in aged sows.

Phlebitis, or inflammation of a vein, is usually the result of some bacterial infection associated with thrombosis. Any obstruction to the venous circulation may cause *dilatation* or *varicosity* of the veins, and may be sometimes seen during post-mortem examinations in pigs.

Neoplasms.—Tumours occur in pigs as in all animals, but they are not common. The most frequently found neoplasm in a pig of bacon size is a so-called *lymphosarcoma* which affects the lymph nodes. This may extend to all the main carcase lymph-nodes, but is most frequently encountered in the hepatic and gastric nodes. It may involve any other organ in the body, and the individual tumours can reach the size of two human fists without any appreciable difference in the general condition of the carcase. Emaciation follows if the animal is allowed to live long enough, and that is usually the case in aged sows affected with lymphosarcomata. (The name is somewhat misleading, as the growth is not a genuine lymphosarcoma, according to Professor Orr of the Birmingham Medical School, but rather in the nature of a neuroblastoma or paraganglioma.)

Papillomata occur on the mucous membrane of the mouth, and sometimes on the skin too. They are generally benign and few in number. *Lipomata* have been found in the omentum and mesentery, and in the latter site they have been known to form a tumour causing strangulation of the intestine. *Hæmangiomata* are occasionally seen in the liver of both sows and bacon pigs. Tumours of a *fibrosarcomatous* nature are not unknown, and so are conditions resembling *carcinoma* and *epithelioma*.

The commonest neoplastic condition in the pig is a *melanomata*. These are melanin-pigmented tumours and they may be found in any part of the animal body, but they are not usually in tumour formation, but rather spread over the part affected as a black or dark-brown colouration, and penetrating a varying depth into the organ, such as the liver or lung.

Melanomata chiefly occur in black pigs, black-and-white breeds, and cross-bred black-and-white, or the so-called blue-black breeds. As the tumour contains melanin it is understandable that these neoplasms are not seen in white pigs. On

the surface of the skin the melanoma takes the form of a black sore-like mark varying in size from about 10 mm. to 100 mm. in diameter. It is not usually raised but rather as though embedded in the skin, and full of greasy melanotic substance. The condition is found in both sexes and in castrated pigs. It is even more frequently seen as a distinctive black colour-

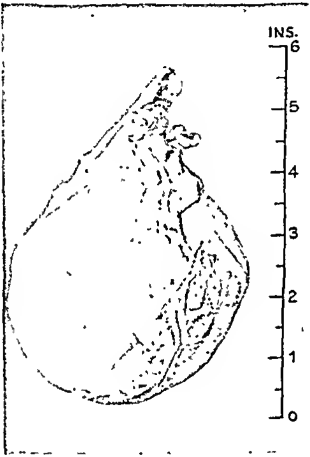

FIG. 80.—AN OMENTAL CYST FROM A PIG.

ation in the lungs or liver, and like most neoplasms it may be seen in any organ and even on the meninges. Another form is more common on the skin of the hams or buttocks, and particularly around the root of the tail. Here it takes the form of slightly raised dark-brown or black pimples, which on section show a curled hair embedded in a mass of melanin. This condition has been called "grubby hams," "shotty eruption," or "shotty hams." Dr. Lapage of Cambridge, who has

examined these lesions, has failed to confirm the assertion of German workers that this is due to *Spiradenitis coccidiosa*. It is more probably a melanotic condition involving the hair follicles, as each little cyst contains melanin.

In the mammary glands of the coloured pig the pigment tends to be scattered throughout the gland tissue, and it looks bad from the customer's point of view when this appears in cured bacon. This is what bacon curers call seedy cut in pigs. It is popularly said to be due to the crossing of a black boar with a white sow, but the condition is certainly very common in cross-bred black-and-white bacon pigs. Although it is the female pig which is most markedly affected, owing to the better development of the mammary tissue, the seedy cut is also sometimes found in castrated hogs near the base of the teat in the subcutaneous tissues. There is a popular supposition that the adult sow does not show this condition, but exceptions do occur, and seedy cut has been seen in such animals. There is a tendency to regard the seedy cut type of melanoma as being in the nature of a physiological displacement of natural pigment, rather than a true neoplasm. There is no reason to assume that the skin melanomata of these black pigs are not malignant.

If aged pigs, as a result of some old injury to the back or loins, rub the part against the walls of the pen, causing an open sore, granulations may grow to such an extent as to cause intense irritation to the animal. Such a growth resembles a fibrosarcoma, and extends deep into the lumbo-dorsal musculature. Medicinal treatment is useless and only aggravates the condition.

Bone Fractures.—These are not infrequently found in pigs. Where the limb bones are involved above knees and hocks, treatment is complicated by the mass of flesh surrounding the bones. Fractures of ribs often heal up without treatment, and are seldom discovered until the callus formation is found after slaughter. Spinal fractures have also been known to heal, provided the break is not complete, and that the pig is very young at the time of the accident. The causes of bone fracture in pigs are numerous. The sow may tread on a little pig, a gate or door may slam upon its leg, whilst numerous accidents may happen in the course of its short life.

Symptoms.—Lameness, or complete refusal to use the limb affected. Swelling over the part, which may be hot and tender to the touch. In spinal fractures there is often a paralysis of the hindquarters. Rib fractures cause some acceleration of the breathing. If the fracture is complete, a splinter of bone may penetrate or irritate the lungs, setting up pleurisy and even empyæma.

Treatment.—This will largely depend upon the severity of the injury and its position, as well as the value of the animal. Prognosis is often favourable in simple rib fractures in the young pig, and also where the lower limb bones are involved. Even a crack in one of the spinal vertebræ will heal if the animal is young, and is isolated in a quiet place away from its fellows. In older animals, where the spinal column or upper limb bones are involved, it may be best to slaughter the animal for food. Fractures of the lower limb bones may be treated by the use of supporting bandages, provided the break is not complete, whilst rib fractures are best left alone, the animal being isolated and watched for any symptoms of pneumonia or pleurisy. The principles of plating and pinning may also be applied where suitable.

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If aged pigs, as a result of some old injury to the back or loins, rub the part against the walls of the pen, causing an open sore, granulations may grow to such an extent as to cause intense irritation to the animal. Such a growth resembles a fibrosarcoma, and extends deep into the lumbodorsal musculature. Medicinal treatment is useless and only aggravates the condition.

Bone Fractures.—These are not infrequently found in pigs. Where the limb bones are involved above knees and hocks, treatment is complicated by the mass of flesh surrounding the bones. Fractures of ribs often heal up without treatment, and are seldom discovered until the callus formation is found after slaughter. Spinal fractures have also been known to heal, provided the break is not complete, and that the pig is very young at the time of the accident. The causes of bone fracture in pigs are numerous. The sow may tread on a little pig, a gate or door may slam upon its leg, whilst numerous accidents may happen in the course of its short life.

Symptoms.—Lameness, or complete refusal to use the limb affected. Swelling over the part, which may be hot and tender to the touch. In spinal fractures there is often a paralysis of the hindquarters. Rib fractures cause some acceleration of the breathing. If the fracture is complete, a splinter of bone may penetrate or irritate the lungs, setting up pleurisy and even empyæma.

Treatment.—This will largely depend upon the severity of the injury and its position, as well as the value of the animal. Prognosis is often favourable in simple rib fractures in the young pig, and also where the lower limb bones are involved. Even a crack in one of the spinal vertebræ will heal if the animal is young, and is isolated in a quiet place away from its fellows. In older animals, where the spinal column or upper limb bones are involved, it may be best to slaughter the animal for food. Fractures of the lower limb bones may be treated by the use of supporting bandages, provided the break is not complete, whilst rib fractures are best left alone, the animal being isolated and watched for any symptoms of pneumonia or pleurisy. The principles of plating and pinning may also be applied where suitable.

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Chapter 13

MISCELLANEOUS CONDITIONS—*Continued*

Meningitis.—Inflammation of the membranes covering the brain is sometimes found in pigs in the course of some specific disease such as swine erysipelas, tuberculosis and Aujesky's disease, or in some injury to the skull. Avitaminosis is also said to result in meningitis, but this is more a predisposing cause, lowering the animal's vitality and so rendering it an easy prey to infective organisms.

Piglets from two to six weeks of age are subject to a *streptococcal meningitis* with a suppurative arthritis. Beta hæmolytic streptococci set up similar lesions. (See chapter on Diseases of Young Pigs.)

Symptoms.—There is first some restlessness, followed by frenzy. This is of short duration, and is then followed by a period of dullness, listlessness and a tendency to burrow in the straw or litter. The animals show no tendency to feed, and there may be some difficulty in getting up and in moving about, with paralysis in some cases and inco-ordination of movement. If the inflammation extends to the spinal meninges, the hindquarters may be completely paralysed. The head is raised or drawn backward. Where the animal is able to get up, it bumps into the walls of the pen, owing to some blindness. Constipation with retention of urine is associated with this condition, and the disease usually terminates fatally.

Post mortem.—There is an excess of a highly cellular cerebrospinal fluid, with an accumulation of purulent material in the subarachnoid space. Smears will show macrophages, polymorphonuclear leucocytes and organisms.

Treatment.—Antibiotic and sulpha therapy is indicated in these cases. If the condition is due to some food deficiency, a correction of the ration with a supply of the necessary vitamins and minerals may produce a recovery. Blood pressure may be relieved by giving a saline purgative. In swine erysipelas the

injection of a large dose of antiserum may sometimes be useful in bringing about a recovery.

Heatstroke.—This may be due to transport during the hot weather, or to being driven along a road for some distance in similar weather, and is often seen in pigs during transit to abattoirs.

Symptoms.—The animal falls out by the roadside or lies down in the waggon; respirations accelerated with mouth breathing. Temperature is elevated and the skin congested; there may be some convulsions, followed by death.

Treatment.—The animal should be removed to a cool place or sprayed with some cold water, and allowed to lie quietly for a while. If the pig is being walked by road, it should be placed in a cart and carried to the abattoir for immediate slaughter if it is in a prostrate condition. If not, it is advisable to rest the animal for a few hours before slaughter.

Electric Shock and Lightning Stroke.—Electric shock may occur as a result of contact with a broken cable, whilst any animal in the open is liable to be struck by lightning; the effects of either depend upon the severity of the exposure, and there may be a complete absence of any symptom or lesion, the animal being found dead. In some cases there may be some burnt areas on the skin, with subcutaneous hæmorrhages or tiny hæmorrhages in the musculature, lungs, and heart muscles. Some blood hæmorrhage may take place from the mouth and nose, and the superficial blood vessels may be congested. Rigor mortis sets in rapidly and passes away quickly. In case of a slight shock the animal may be struck down and recover fairly easily, appearing dazed and walking with a "drunken" gait. There may be some paralysis of the hindquarters, and even fracture of the spine. Electricity is now used extensively for the stunning of pigs prior to slaughter. In such cases the animal is not killed by the shock, and the current of from 60 to 70 volts is applied to the region of the brain, one electrode on either side of the head, for a maximum period of not more than ten seconds.

Pigs have been known to recover and appear none the worse after an exposure to such a current for about three minutes, and the writer has performed the castration operation upon adult boars under electrical anæsthesia. On the other

hand, cases are known of pigs having burnt areas on the skin and fractured bones when the current is applied for more than ten seconds. Electricity would appear to vary in its effect upon different pigs as it does upon human beings, some animals being more susceptible to its effects than others. Electric goads are also marketed for driving a recalcitrant animal or a savage boar, etc. These instruments are not much bigger than a large electric torch, and the voltage is seldom more than about 12 volts. The current is released when two contact points are pressed against the animal's skin. Their effect is to give a mild shock and to frighten the animal. Animals as a rule are more susceptible to electric shocks than human beings, and a shock of small voltage will often cause great panic.

Alternating current is considered more dangerous than direct. High direct voltages of over 300 volts are dangerous, and alternating currents of 120 volts (if of between 15 and 60 cycles) may also cause death. Alternating currents of high voltage but of a very high frequency are not considered so dangerous. A wet skin will so lower the animal's resistance that low currents can cause heart fibrillation and result in death. High tension currents affect the central nervous system, causing respiratory inhibition.

Treatment.—Quiet rest with some warmth is the best treatment, but there is always the possibility of some internal hæmorrhage and even of fractured vertebræ, so that slaughter in an endeavour to salvage the meat may be desirable. In valuable animals quiet rest, with artificial respiration if necessary, may be all that is required. Injections of acetylcholine have been reported to give good results in experimental animals to protect against ventricular fibrillation.

Tumour formation in the brain is seldom encountered in pigs, as the animals are slaughtered at a comparatively early age. The effect of tumours of the brain is to cause pressure on certain parts of the brain, and symptoms depend largely upon the site of the tumour. The symptoms may vary from some dullness to acute frenzy, paralysis of limbs or parts of the body, inco-ordination of movement, walking in circles, or bumping against the pen walls. As a rule tumours are slow-growing and symptoms may appear only gradually. The

types of tumours usually found in animals are psammomata, cholesteatomata, sarcomata, gliomata, melanomata, and carcinomata. Tuberculosis and actinomycosis may also give rise to certain growths in the cranial cavity. All these conditions are extremely rare in pigs. (See Neoplasms.)

Epilepsy.—Epilepsy in the true sense does not occur so often in pigs, and many of the so-called "fits" in pigs are eclampsia fits. True epilepsy is said to be hereditary, and is due to an increased irritability of the reflex centres. In the pig impaction of the stomach following deficiencies of minerals in the diet will often produce a condition resembling epilepsy, as also will the presence of ascarides in the intestine set up so-called fits. Aujesky's disease in pigs also shows symptoms resembling epilepsy. (See also Avitaminosis.)

Symptoms.—The animal will fall down suddenly with rigid muscles, the limbs being held very stiffly. The animal becomes unconscious; there is some champing of the jaws, frothing at the mouth, and rolling of the eyes, with dilated pupils. Respirations may be intermittent, and the superficial blood vessels congested with blood. Fæces and urine are passed involuntarily.

Treatment.—Dietetic deficiencies may be responsible for epileptic-like conditions in young pigs, and it has been found that experimentally a deficiency of vitamin B_6 sets up a so-called epilepsy in pigs. Treatment will therefore consist in the correction of any dietetic errors, vitamin deficiency or mineral deficiency. Worm infection should be treated by vermifuges. Barbiturates or chlorpromazine by injection can be given to control the symptoms.

Injuries to the Spinal Cord.—Injury to the spinal vertebræ occurs in young pigs, and when the vertebræ heal there may be some callus formation causing pressure on the cord. In other cases there will be a deformity of the spine following a severe injury to the vertebræ. These injuries are often encountered in the dorsal and lumbar vertebræ, and they appear to heal up, the animals being fattened and the condition not discovered until after slaughter. Tumours are seldom if ever found on the spinal cord in pigs, but a melanotic pigmentation is sometimes discovered after slaughter.

Injury is occasionally sustained by adult animals during

service. Either sex may be affected and the long backed breeds such as Landrace are particularly susceptible.

Symptoms.—Where there is a severe injury and pressure on the spinal cord there may be paralysis of the hindquarters. If the injury is in the cervical vertebræ the condition is much more serious, the upper part of the neck being an especially dangerous place for such an injury, as the respirations may be interfered with and death soon follow. An injury lower down the spine may cause paralysis of only the hindquarters,

FIG. 81.—CROSS-SECTION OF THE LONGISSIMUS DORSI MUSCLE OF THE PIG, SHOWING ALMOST COMPLETE REPLACEMENT OF MUSCULAR TISSUE BY FAT.

with loss of sensation in the parts affected. Most spinal injuries found in pigs at post-mortem examination, and of apparent old standing, are fractures with deferred displacement.

Treatment.—The animal should be immediately slaughtered where the condition is suspected, although young pigs will often make a good recovery if given some attention at feeding time, and left to lie quietly in their pens without undue interference. Where paralytic symptoms develop they should be slaughtered.

Myositis.—Inflammation of the muscles may result from a severe injury, from wounding or by extension from a severe

bone fracture, from trichinosis, or from a muscle rupture. This latter condition is sometimes encountered in sows in the muscles of the thighs when the animals are driven over a slippery floor. The hind-legs may slip apart and some of the muscles be torn near their attachment to the pelvis, causing considerable internal hæmorrhage and setting up an inflammatory process. The *Trichina spiralis* parasite may also set up inflammation in the muscles and cause acute pain like muscular rheumatism. A *chronic myositis* may also affect the lumbar muscles in pigs, and a *fatty degeneration* of the muscles along the spine is sometimes found in pigs in which the muscular tissue may be completely replaced by fat.

The condition of myositis may be of a rheumaticky nature, with no apparent visible cause. Such cases are often associated with deficiency diseases, and treatment is similar to that prescribed for such diseases and for rheumatism in general. In cases of muscular injury treatment will depend upon the site. If the pelvic muscles are ruptured, slaughter is advisable, as the animal will be unable to stand on its hind-legs. Where there is some *muscle atrophy* the condition may be of nervous origin, and massage or mild blistering will prove useful in adult pigs.

A *White Muscle* condition occurs in pigs, without the lean meat being necessarily changed to fat. The muscles affected are generally the longissimus and the ham muscles. The condition has been found in British pigs long before the importation of any Swedish-type Landrace pigs into this country. These muscles appear loose in texture and very pale in colour, almost white, with some exudation. They stand out from the pink normal muscles surrounding them. In these white muscles a pH of 5·1 or below has frequently been found. Muscle-fibres are twisted and broken, the protein gel coagulated, and in those with pH below 5 the cross-striation is missing, the general picture being like that in isolated muscle where rigor mortis has been precipitate due to an abnormally high rate of breakdown of adenosinetriphosphate.

Erythema.—Erythema, or reddening of the skin, is often found in pigs associated with such diseases as swine erysipelas, swine fever, paratyphoid, etc. As a rule there is little or no structural change in the skin except in the case of erysipelas

and certain urticarial conditions or a symptomatic erythema due to dietetic conditions.

Symptoms.—The most important is a reddening of the skin due to a condition of active hyperæmia; there may also be some heat and some irritation. In the case of swine erysipelas there may be extravasation into the deeper structures and into the subcutaneous fat, with the formation of scabs on the skin. There is also a condition of erythema produced in pigs following transit over long distance by rail. At one time this condition was called lime burning, but lime is no longer used as a wash for the interior of railway waggons, and the name disinfectant burning has sometimes been applied to it.

Transit erythema has been attributed to the use of too strong solutions of disinfectants in washing out railway waggons, and to the presence of urine. It usually affects pigs travelling on long journeys, and invariably the pigs affected appear to have been lying down quite a lot on the journey, and the urine passed by the pigs soaking into the woodwork, mixing with any disinfectant present in the floor, will set up an irritation when the pig's warm body comes in contact with the floor for some time, the visible lesions being an erythema or reddening of the skin along the belly and hams—the pressure points of the pig. The erythema can take the form of red patches on the skin, and in severe cases the superficial layer of skin may be necrotic or burnt a black colour, with extensive extravasation of blood into the subcutaneous fat. Carcases hanging in abattoirs after slaughter will give off an odour characteristic of the coal-tar disinfectants, but this odour is not always present. The lymph glands are congested and the carcase presents a fevered appearance in very bad cases. In the erythemas caused by dietetic errors the tiny red patches may appear all over the body, and not only on the belly and hams.

There is an apparent erythema found in the course of post-mortem meat inspection of slaughtered pigs. The carcase sets firmly, and the skin appears pronouncedly red, whilst all carcase lymph nodes are normal, with the fat white and firm. These are cases where the live animal has accidentally fallen into the scalding water tub before slaughter, the animal

having been immediately fished out, slaughtered and dressed as though all was normal. Such carcases often bleed out well, but the skin tells the tale.

Treatment.—The disinfectant or transit erythema only occurs in pigs sent for slaughter, and treatment is not called for in such animals. In other cases an examination of the ration will often reveal deficiencies or an excess of protein, and the condition will then be remedied by providing a properly balanced ration, with some halibut- or cod-liver oil. The administration of saline purgatives often helps to clear up the skin irritation, and clean bedding should be provided for the affected pigs.

Pig Urticaria.—Urticaria, or nettle rash as it is sometimes called, is believed to be due to an excess of protein in the pig food, or to some dietetic errors or deficiencies. Variola may also produce similar lesions in pigs.

Symptoms.—Small circular areas or weals form on the skin all over the body. The rash can be distinguished from that formed in swine erysipelas, as it is usually in the form of little circular weals which seldom attain a diameter of more than ½ inch. It may be found on any part of the skin of the body and legs. When the weals burst they leave small circumscribed red areas all over the body.

Treatment.—A saline purgative or a dose of calomel should be given, and the diet corrected and rendered more laxative. Powders composed of charcoal, sodium sulphate, sodium hyposulphate and sodium bicarbonate, given in the food, are also useful in helping to clear up this condition.

Eczema.—In this condition superficial layers of the skin may be inflamed in patches, and there will be some hyperæmia, with the production of small vesicles which may either be discrete or become confluent. These vesicles may burst, producing a serous discharge and later forming scales over the parts. The eczema may be dry or moist, depending upon the amount of fluid discharge. The condition is not contagious, and is believed to be due to dietetic errors, nervous causes, or to kidney disease. If due to the last, there may be some uræmia and a urinous odour given off from the body. Dirt, irritants applied to the skin, and skin parasites may cause lesions very similar to eczema, but true eczema is usually of

internal rather than external origin. Pus organisms may invade the lesions, producing a chronic condition.

Symptoms.—A vesicular eruption may be observed on the skin, chiefly in young pigs, causing itchiness, and there may be some pruritus. When the vesicles burst or are broken some little serous fluid may ooze out and scales may form over the lesion, or if pus organisms invade the vesicle a small ulcer may form. When the condition is due to kidney disease symptoms of nephritis are present, and a urinous odour may be detected. The animal affected is generally unthrifty, and this unthriftiness may be due to dietetic errors rather than to the eczema. In pigs the eczema is usually secondary to some dietetic deficiency or protein excess.

Treatment.—The diet should be attended to and properly balanced. Vitamins in capsular form or as halibut- or cod-liver oil should be given, with a mild purgative. Other useful medicaments consist in the iron treatment as applied in anæmia —Parrish's food, Easton's syrup, and iodide of iron. Externally the part may be dusted with a powder composed of oxide of zinc and boracic powder, after first cleansing with a mild antiseptic. Zinc ointment is also useful or a lotion made from zinc carbonate, zinc oxide, coal tar, and lime water. Sulphur ointment, or a combination of sulphur and zinc ointments, salicylic acid ointment, and in obstinate cases double B.P. strength carbolic ointment, have proved useful. Undoubtedly organic sulphur compound such as bisbutyl zanthogen (Dennynox) in oil, or mesulphen (Sudernox), are far better than the older treatment mentioned.

Scleroderma.—Hardness of the skin is usually met with in the shoulder region in adult boars. The skin becomes very thick and hard. It can be cut only with very great difficulty, and it appears to be a normal condition in old boars, especially where the skin in the shoulder region may be like a rhinoceros hide, and should not be regarded as due to any disease. In order to soften this hard skin somewhat, and so produce less waste, which in turn leads to a better price being paid to the owner, some breeders have their old boars castrated about three months prior to sending them to the butcher for slaughter. By the time the castration operation wounds have healed, the animal has generally put on some

weight, and being now a neuter, is not so rough. It is now known as a stag pig, and commands a higher slaughter price than does a boar.

Dry-feed Dermatitis.—This is seen in young pigs on a dry feed. The epithelium is thickened due to an excess of keratinized tissue. Red pimples are seen on the belly, and the skin is wrinkled and cracked as though mange were present. It is not an infectious condition, but is exacerbated by the addition of bone meal or high calcium containing substances to the food. Some feeding experiments have suggested that a deficiency of zinc can cause the condition, and this can be corrected by adding zinc carbonate to the ration in the proportion of 8 ounces to one ton of meal. (See Parakeratosis.)

Alopecia.—Baldness is chiefly encountered in the Ulster pig, and appears to be a normal characteristic of that breed. Baldness in other breeds may be due to skin parasites or to some disease of the hair follicles, general debility, or to some interference with the normal skin nutrition, and is usually of no consequence in the pig.

Acne.—Pimples may occur in inflammation of the hair follicles or sebaceous glands. When these lesions appear in patches they are called *furuncles*, and they may become infected, forming small boils. The skin parasite *Demodex folliculorum* is said to be responsible for some of these conditions in pigs, causing numerous small black or yellow spots on the skin. Turned-in hairs are also said to cause acne lesions. German writers ascribe a condition in which black acne-like pimples containing turned-in hairs and brown sebaceous material are found around the roots of the tail and on the buttocks of pigs to *Spiradenitis coccidiosa*. It is a condition sometimes seen in fat pigs and known as shotty hams or grubby hams.

Treatment should be directed to the provision of good food, clean surroundings, and the application of skin lotions to the parts—sulphur liniment, or a lotion composed of ½ oz. of oil of tar to a pint of rape oil carefully applied.

Dermatitis.—This is due to a variety of causes. In the United States a dermatitis of piglets (infective epidermitis) has been described affecting pigs from one to eight weeks of age, and causing a mortality rate of over 60 per cent. in some cases

The ætiology is obscure, and whole herds can be affected, whether reared indoors or on pasture.

Symptoms—Listlessness, a dull skin covered by dry, brittle scales. On white pigs light-orange patches appear, and grey patches on black pigs. The skin becomes thickened, and in a few days it seems oily. Small brown spots show at the hair roots and sweat glands. Anorexia, depression and loss of weight follow, with some constipation. In the peracute form there is a marked erythema, with moist sticky exudation and scab

FIG. 82.—RINGWORM IN THE ABDOMINAL SKIN OF A BLACK-AND-WHITE PIG.

Note how the black root hairs show up in this skin after scalding, scraping and singeing.

formation. The feet are usually involved. The pigs become dehydrated, emaciated, and die within three to five days. In the acute form the skin is greasy, thick and wrinkled, and brown spots increase in size. Vesicles and pustules develop, rupture and form ulcers—the dried exudate forms scabs, fracturing to produce deep fissures.

The least common form is the chronic type, where the thickening and wrinkling of the skin is more marked. Death is delayed for three weeks, or there may be a slow recovery.

Post mortem.—Lesions are confined to the skin. The

lymph nodes are enlarged, and secondary bacterial infection is often present.

Treatment.—Antibiotics are worth trying, and so are organic sulphur compounds. Vitamin and mineral supplement in the food, and when such young pigs are affected, the care of the pregnant sow needs attention.

Ringworm.—Ringworm, or dermatomycosis, in the pig is caused by a fungus or mould of the Hyphomycetes class, *Trichophyton tonsurans* (*T. megalosporon*), *T. mentagrophytes* or *Sabouraudita* (*Microsporum*) *audouini*, the former parasite being of the large-spore type and the latter a small-spore species. The parasites occur in the form of hyphæ and spores, the hyphæ being branched and segmented. The ectothrix type is found twisting around the affected hairs, and the endothrix type is usually found in the superficial epithelium and substance of the hair. The spores are formed from the breaking up of the threads, and in the Trichophyton chains of spores can be demonstrated, whereas the Sabouraudita show both hyphæ and spores.

Tr. mentagrophytes has been demonstrated in the pig in Britain by McPherson.

Ringworm is spread by contagion from animal to animal, and young animals are affected. The predisposing cause of ringworm appears to be general neglect leading to unthriftiness, as the condition seldom occurs in healthy pigs kept under hygienic conditions. Pigs suffering from malnutrition and pigs kept on dung litter in straw yards are those that usually develop ringworm.

Symptoms.—Rounded patches of a mild superficial inflammation are seen on the skin of the hams, shoulder, flanks, and head in young pigs. The lesions become confluent and extend over a wide area of the skin. There is some slight exudation and proliferation of the epidermal cells, with itchiness in the early stages and during the healing process. The ring form is characteristic of this condition, and when the lesions reach a certain size they cease to enlarge, further extension being by lesions coalescing. The lesions appear as slightly raised reddish patches on the surface of the skin. Scab formation and suppuration are not common in pig ringworm.

In young pigs there is a lesion resembling *pityriasis rosea* of man, where numerous red patches are covered with bran-like scales, and which tend to heal at the centre.

Treatment.—In order to be certain that the condition is ringworm the Trichophyton may be demonstrated in the lesion by taking material with a knife from the margin of the area affected and heating in a 10 per cent. solution of caustic potash, teasing out, and examining under a sixth objective an unstained preparation, when the spores can easily be seen, as well as the frayed hair. The condition heals up with the improvement in general health of the young pig, but affected pigs should be isolated and the lesions treated with sulphur ointment, mercury ointment, or phenol ointment, 6 per cent. If the lesions are extensive the sulphur ointment treatment should be used, after first dressing the lesions with a mild iodine solution, Lugol's iodine solution or Bayer's Odylen may be useful in small lesions. Creams or ointments are now available containing the active constituent of oil of clove (Eugenol) with phenyl mercuric acetate, and they are very effective against the fungus. Treatment plus isolation and some extra attention to the feeding will usually suffice to clear up the condition.

Mucomycosis and Moniliasis.—Gitter and Austwick have found these moulds and fungi responsible for certain lesions in piglets. The Mucoraceæ are moulds found in soil, manure and starchy foods (*e.g.* bread). They possess coarse, non-septate mycelium, with abundant aerial mycelium, generally white or grey. The spores are either black or brown. Of the yeast-like fungi *Candida albicans* is the particular one implicated, although *C. tropicalis* and others have also been isolated from the stomach contents of unweaned pigs.

Symptoms.—Unweaned pigs scour and vomit, they appear dull and there is some anorexia. Death may occur within 12 hours of the onset of the symptoms.

Post mortem.—The stomach is the chief organ affected and it is either empty or contains curdled milk, as one would expect. There is œdema of the stomach wall, and congestion of the gastric mucosa with hæmorrhagic areas in the diverticulum. Ulceration of the mucosa leads to necrotic areas, where the presence of branching hyphæ can be microscopically demon-

strated. The stomach contents will show ample evidence of *C. albicans* or other fungi.

Treatment.—It is obvious that pigs so young are already in a very weak state when born, due to the way the pregnant sow has been managed in the previous months. It is of no use turning these sows on the old pasture land long exhausted by

FIG. 83.—SKULL OF LARGE BLACK SOW (ANTERIOR ASPECT), SHOWING SOME TEMPORARY INCISORS STILL IN POSITION.
Note also wear on side of the cut canine (upper).

cattle and sheep. Pregnant sows need to get their teeth into luscious pasture, and not be turned out on to land fit only for rooting up. Antibiotic treatment of the little pigs, cleansing and disinfecting of pens and utensils, and the provision of warmth, anæmia treatment, and tonics are all indicated, but above all, *prevention* by attention to the pregnant sow.

Dental Diseases.—Diseases affecting the teeth are very

seldom encountered in pig practice, but there may occasionally be abnormalities of development, persistent milk teeth, three premolar teeth in the lower jaw instead of four, overlapping incisor teeth, and inequality in the length of the jaws. The term hog mouth is often applied to animals of species other than the pig when the lower jaw is longer than the upper jaw, although if the skull of a normal pig be carefully examined it will be found that this tendency for the lower jaw to be longer than the upper is not characteristic of pigs. In the short-

FIG. 84.—SKULL OF MIDDLE WHITE SOW, SHOWING UNEVEN WEAR OF MOLAR TEETH AND LOSS OF ONE TOOTH.

snouted breeds the upper and lower jaws sometimes show this irregularity, but normally both jaws are about equal in length and the incisor teeth usually meet. In the long-snouted breeds the upper jaw is often slightly longer than the lower. The term hog mouth may have arisen from the impression given on looking at the live pig—viz. that the lower jaw is longer than the upper. Anatomically that is not the case, and hog mouth is an abnormality in pigs as in other animals.

Dental Caries.—This condition is one in which the cement

and dentine of the tooth are destroyed, leaving the enamel intact, and is not common in pigs, except occasionally in old sows. Bacteria, aided by food lodging between the teeth and decomposing there, are said to be the cause. Dental caries seldom gives rise to any noticeable clinical symptoms in pigs, and as is the case with most dental conditions in the pig, they are not discovered until after slaughter, when a caries lesion may be found as a hollow cavity in one of the cheek teeth.

Tartar.—This is not so common in pigs up to slaughter age, but in old animals a brownish-black deposit may be seen on the teeth at their base. It is believed to be formed from a carbonate of lime and magnesium, and phosphate of lime, mucus, bacteria and organic matter, and does not appear to cause any ill-effects in pigs.

Alveolar Periostitis.—This may be caused by food getting in between the gum and tooth, and so allowing bacterial invasion. Deep-seated caries, fractures, tumours, etc., may all lead to this condition. The tooth may become somewhat loose, the gums inflamed and painful, and deep-seated abscesses may occur, especially in the small sinus at the symphysis of the lower jaw beneath the roots of the incisor teeth. Such abscesses, which are commoner than is believed, are not usually discovered until the animal is slaughtered and the head split for sale or for manufacturing. A dental fistula may form in which there is a suppurating tract opening on the jaw close to the affected tooth.

Dental Tumours.—Dental tumours are very rarely found in pigs. Such tumours may consist of odontomata, which are composed of tooth structures, or they may occur in the form of a bony exostosis.

Treatment of dental conditions in pigs is seldom if ever called for, as the animals are usually slaughtered at a young age, and on the whole pigs are remarkably free from dental troubles as compared with other species of farm animals.

Anormalities.—Abnormalities are found in young pigs, as in other animals, the most frequent being hernias, scrotal and umbilical. In castrating a little pig with scrotal hernia there is often a danger of sutures afterwards being torn and protrusion of the bowel through the operation wound, but

even where both types of hernia have been successfully operated upon, the site of the hernia is well marked in the pig when slaughtered for pork or bacon later on, and necessitates a good deal of trimming by the butcher in the region of the ham or belly, thus reducing the value of the saleable product. For this reason it may be advisable not to attempt castration of little pigs with scrotal hernia. Pigs with umbilical hernia may be surgically treated or left to be fattened up and slaughtered as porkers. A record should be kept of such animals with their dams and sires in order to ascertain if there is a tendency in either parent to an hereditary predisposition to the production of such pigs. A good deal of valuable information could be collected if such records were carefully kept and studied, and some well-needed light thrown on the condition.

Pigs are sometimes born with imperforate ani, necessitating surgical interference in the nature of a small incision and suturing the bowel to the skin wound. Often such cases are not considered of sufficient economic importance to necessitate a visit by the veterinary surgeon, and the affected pigs are destroyed.

Hermaphroditism is also found in pigs. These animals are not always true hermaphrodites, but rather sex-intergrade pigs, and are known to farmers as wilgils or wildews. From their external appearance one would be inclined to classify such pigs as gilt pigs, but the clitoris is generally enlarged with the labial commissure protruding to such an extent as to appear as though a small penis were pointing backwards just below the anus. In some cases a small projection may be found just behind the umbilical region. Baker has described the anatomy, genetics, and developmental physiology of these sex-intergrade pigs. Baker had his attention first drawn to this condition in pigs by the natives of the New Hebrides, who apparently were aware of the inherited tendency to sexual abnormality in pigs, and made use of sex-intergrade pigs in certain of their religious rites Sows known to have produced such pigs were mated with boars from a known sex-intergrade family. On his return to this country he found that the tendency to inherit this abnormality is true also of British pigs. In an anatomical examination of the genitalia of these pigs he found that some were true hermaphrodites, having an ovary on one side and a testis on the other, with a patch of ovarian tissue

at the anterior end. A uterus and vagina are usually found, and some have two testes just beneath the skin, but not in a proper scrotum. Others have the testes in position and are castrated normally. As regards their true sex, Baker concludes that they must be regarded as masculinized genetic females, his reasons being summed up as follows:

(*a*) The ovary, when present, is a typical ovary with growing oocytes.

(*b*) The external genitalia are always essentially female.

(*c*) The closest approach to normality in the pigs he examined was an approach to the female sex.

He summarizes his paper by pointing out that sex-intergrade pigs show all variations between complete and abortive development of the derivatives of the Müllerian and Wolffian ducts. The external genitalia are always essentially female in type. The seminiferous tubules are degenerate even when the testes are descended. In the true hermaphrodites he examined the ovary was on the left side and the ovo-testis on the right, and in each case the ovarian part of the ovo-testis was anterior. He states that it is not improbable that all sex intergrades were true hermaphrodites in embryonic or early postnatal stages. The tendency to sexual abnormality in pigs is inherited, and the ratio of normals to sex intergrades among the offspring of intergrade-producing parents is 8 : 1 or >8 : 1. The abnormality does not appear to be associated with abnormality of any of the ductless glands. Sex intergrades often have male sexual instincts, and it is reported that some of these sex intergrades show signs of œstrus, even though their instincts are male. From the author's observations, this sex-intergrade condition is found in about 0·2 per cent. of slaughtered British pigs.

Cryptorchids or rig pigs are also occasionally found. Generally one testicle is undescended; cases are encountered, however, in which one testis is undescended at the time of castration, but appears in the scrotum by the time the pig is ready for slaughter.

Various other freaks are sometimes seen in pigs, such as pigs with five toes, misplaced internal organs, one kidney instead of two, and a variety of malformations of various organs.

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Chapter 14

DISEASES CAUSED BY ANIMAL PARASITES

PARASITES of animal origin may be found living as endoparasites within the host's body, or as ectoparasites outside or on the host. The amount of harm done to the host depends largely upon the numbers of parasites present and the degree of adaptation that has taken place between the host and the parasite. Parasites cause harm to the host in a variety of ways, as by feeding on the host's tissues or absorbing food intended for the host, sucking blood, causing mechanical obstruction, destruction of tissues, the formation of growths, irritation or by secreting a toxin, and by transmitting some disease.

As a general rule most parasites associate with one host species, and have certain predilection seats in or on that particular host. Some parasites, as, for instance, certain of the tapeworms, exist as worms in one species and have their cystic stage in another. Most of the worm parasites are usually found in the alimentary canal, but some are erratic and may be found in the organs. Resistance or immunity to these parasites does occur, and factors such as nutrition, age and vitality also influence the resistance of the host to the parasite.

Animals may be infected in various ways: by direct contact, as in the case of lice, through food or water, through inoculation by intermediate hosts, direct attack by the parasites, and through congenital transmission.

Methods of examining Parasites and Eggs.—Skin parasites are examined by taking scrapings, clearing the material in potassium solution or lactophenol solution, and making a direct examination. Another method is to boil the material in 10 per cent. caustic potash until the hairs are broken up and then centrifuge with equal parts of glycerin and water, when the parasites will float on top.

Fæces can be examined for adult worms, segments of tape-

worms and worm eggs. There are various ways by which fæces can be examined for the presence of parasitic eggs.

1. *Sugar Flotation Method.*—About 30 g. of fæces should be stirred up and well mixed with about 500 ml. of water, and then strained through a sieve with a mesh of 1 mm. or a series of sieves with meshes ranging from 0·25 to 3 mm. The mixture is then left to stand for ten to fifteen minutes, so that a sediment forms, and the supernatant fluid is poured off. The sediment is then shaken up and some poured into a centrifuge tube with an equal volume of a concentrated solution of sugar. Glycerin may also be used, according to Mönnig. The mixture is then centrifuged for one to two minutes at 1,000 revolutions, when the eggs will float at the top. The eggs can be transferred to a slide by touching the surface of the mixture with the end of a squarely cut glass rod.

2. A method used largely for nematode eggs is the Willis method. About 1 ml. of a mixed specimen is diluted with 10 to 20 ml. of concentrated salt solution in a narrow cylinder filled to the top with liquid. A clean slide is then placed on top of the cylinder in contact with the liquid, and is left in position for from thirty to forty-five minutes, after which it is carefully removed, inverted and examined.

3. In making a direct examination a small quantity of the fæcal matter is placed on a slide and diluted with a drop of water, spread out, and examined. Mönnig recommends that at least three slides from different parts of the fæcal sample should be examined.

If a diagnosis cannot be made from the eggs, cultural methods are adopted in which the larvæ are cultivated from the eggs hatching in the free state, whilst egg counts can also be made when slightly more elaborated technique is employed.

The Stoll metbod of diagnosis by an egg count, as recommended by the British Veterinary Association, is to weigh out about 3 grammes from the fæcal sample and add this to 42 ml. of water in a glass-stoppered bottle containing about twenty glass beads. The stopper is then fitted on the bottle and the bottle sbaken thoroughly until all tbe fæcal material is broken down. The larger particles of debris are then separated by pouring the mixture through a strainer into a cup. The strainer contents are then discarded and tbe

strained fluid is stirred to ensure an even suspension of eggs. Before the eggs have time to settle at the bottom 0·15 ml. is removed by pipette and ejected on to a microscope slide and covered with a $\frac{7}{8}$ inch square cover-glass ready for examination with a two-thirds objective and $\times 5$ or $\times 6$ eyepiece. The eggs seen should all be counted, whether under the cover-slip or in the fluid which has escaped from under the edge of the slip. The figure obtained from such a count is multiplied by

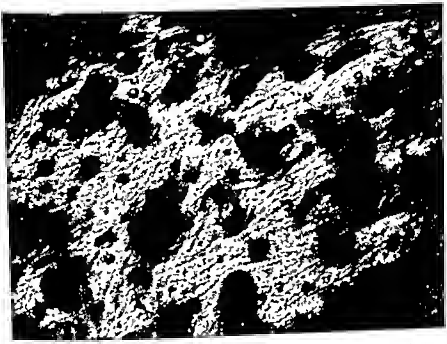

FIG. 85.—SHOTTY ERUPTION. CLOSE SHOT OF A PIECE OF AFFECTED SKIN COVERING A HAM.

100 to give the number of eggs per gramme of the original fæces sampled.

Quantitative methods using a McMaster or Gordon-Whitlock counting chamber are likely to yield information of greater value than qualitative ones. These techniques, however, require a certain amount of specialized apparatus and standardization of procedure if accurate interpretation of results is to follow.

In the case of filarial worms their larvæ may be found in the blood and an examination of some drops may be necessary to establish a diagnosis. For this purpose a drop of fresh blood may be placed on a slide, covered with a cover-slip and

examined. The larvæ of some species may only be found in the blood during night-time, others appear in the blood during the day-time, so that many examinations may be necessary in order to find them. Where larvæ are few in number a thick smear is best. The film should be air-dried as soon as possible, and then placed in some distilled water, face downwards, in a slanting position against the side of the vessel until the smear is dehæmoglobinized. The smear should then be removed from the distilled water and air-dried, after which it is fixed in methyl alcohol for ten minutes, and it can be stained either by Giemsa's stain (azur I, azur II, and azur II eosin) or Böhmer's hæmatoxylin, which is said to be better.

Allergic reactions occur, but are not as specific as in the case of bacterial allergic reactions. An intradermal reaction (Casoni reaction) has also been used for diagnosis of Echinococcus infection in human beings, using sterile hydatid cyst material from slaughtered animals. Powdered worm material applied to scarified skin has also been used to produce a skin reaction. The complement fixation test and precipitin reaction have also been applied for diagnostic purposes.

Protozoal Diseases.—The protozoa are unicellular animals, the simplest forms of animal life, and some are found parasitic and the causes of certain diseased conditions in animals and man. Little work seems to have been done on protozoal conditions in the pig, and most of these protozoal conditions are found in tropical climates and in the East.

Entamœba.—These are of the order Amœbida and class Rhizopoda, and are found in the alimentary tracts of many animals, often in the vegetative stage. They are smaller than free-living amœbæ, and encyst before being passed out of the animal body in the fæces. *Entamœba suis* is said to occur in the ulcers in cases of swine fever in the pig. It is possible that the various entamœbæ are all, or nearly all, one species. Many are harmless, and no illness has been reported in the pig as being due to them.

Coccidiosis.—Various coccidia have been found in pigs from time to time. *Eimeria zurni* is held responsible for some pig dysentery. *Coccidioides immitis* has been found to cause lesions of coccidial granuloma in pigs in America, the condition being found on a post-mortem examination in the form of an

actinomycotic type of lesion in the bronchial and mediastinal lymph glands. Other coccidia found in pigs have been *Eimeria debliecki*, *E. perminuta* and *E. scabra*. *E. debliecki* has been accused of causing diarrhœa, inco-ordination of movement, retardation of development and even death in young pigs in Venezuela. Novicky found an infection rate of as high as 63 per cent. in pigs between three to six months old, dropping to about 25 per cent. in adult sows. Immunity may account for the absence of infection in old pigs.

Symptoms.—Coccidiosis usually affects young pigs, notably those newly weaned, as well as pigs already weakened by some dietetic deficiency. Many febrile conditions in newly weaned pigs are thought to be due to coccidiosis. Inappetence, unthriftiness, some pyrexia with accompanying discoloration of the ears, are other symptoms. There is, as one would expect, diarrhœa, at first yellow, later becoming red, and taking on the form of dysentery.

Treatment.—Diagnosis is made by finding oocysts in the fæces, and the condition is best treated by attention to the general hygiene and to the food. Medicinally, sulphadimidine, acridine, and iron tonics; thymol in 5-gramme capsules may also be useful. The pigs affected should be separated from the healthy pigs, and the healthy pigs kept off damp pastures, given some green food, milk, minerals and vitamins.

Spiradenitis coccidiosa.—This coccidia is said by German writers to be responsible for the condition occasionally seen in the skin around the root of the tail and along the buttocks of pigs, and known as seborrhœa, grubby hams, or shotty eruption. The condition consists of round papules, dark brown or black in colour, extending over a portion of the skin of one or both hams in a pig. On opening these papules they are seen to be filled with a brownish, greasy material in which the bristle may be found curled up. It originates in the sweat glands, and has no effect upon the general health of the pig. (See Neoplasms.)

Arthropoda

Of the arthropoda, or invertebrates having jointed legs, many may cause intense irritation to pigs without actually being parasitic. They may also help in the spread of disease.

Insecta

This class of arthropoda is characterized by the body of the adult being divided into head, thorax and abdomen. The head has a pair of antennæ; the thorax bears three pairs of legs and often two pairs of wings.

Diptera.—This order usually has only one pair of wings, and includes flies and mosquitoes.

Musca domestica.—The common house fly has a world-wide distribution, and may act as a mechanical carrier of disease and of worm eggs, as well as being an intermediate host of several parasitic worms. It is estimated that the fly lays from 100 to 150 eggs at a time, and that each fly is capable of laying about 600 eggs. The fly develops in fæcal matter and in all sorts of decaying organic matter. The eggs are about 1 mm. long and whitish in colour, the larva hatching in twelve to twenty-four hours and developing into a maggot in from three to seven days, pupating on the ground for from three to twenty-six days, depending on the temperature, fertilization taking place a few days after the emergence of the fly. The adult fly lives for a few weeks only in summer, but may live longer in cold weather, and a number of generations may develop in one summer. The eggs are able to resist cold and produce a new crop of flies in the spring. The larval stages in fæces become infected with worm eggs as well as with bacteria, whilst the adult fly infects itself by feeding on contaminated material and by carrying bacteria on its hairy legs. The possibility of the fly thus acting as a carrier of disease is great, as it has a habit of regurgitating fluid from the crop. It is known to be a carrier of pathogenic organisms such as those causing tuberculosis and anthrax, and apart from being the intermediate host of some worm parasites affecting animals, it also helps to spread the eggs of many others.

Certain types of Scandinavian fattening houses may be swarming with flies during the summer months, and apart from the fly's possibility as a disease carrier it may worry the pigs considerably, and thus cause interference with the fattening process.

Control measures include the frequent cleaning out of manure and its dispersal on to the land, and the spraying of

window ledges, etc., with a DDT solution. One pound of powdered borax to every 16 cubic feet of manure will destroy about 90 per cent. of the fly larvæ without damaging the fertilizing value of the manure.

The **Blue-bottle** or **Blow Fly** (*Calliphora vomitoria* or *C. erythrocephala*) lays its eggs on food, such as meat, bacon, hams, cooked meats, etc. In hot weather the larvæ hatch out in a few hours. If the weather is unfavourable, they may take as long as two days to hatch. They develop for ten days before entering the pupating stage, but growth may cease if the temperature falls below 44°F.

The **Ham Fly** or **Cheese Fly** (*Prophila casei*) can also lay its eggs in clusters on hams and bacon. The larvæ or ham kippers are about one-third of an inch long, and they develop on the meat itself. They have a tendency to burrow deep into the meat, and when their larval period is at an end they leap on to fresh meat to find dry spots for pupation.

The **Grey Meat Fly** (*Sacophaga camaria*) also deposits its larvæ on meat, and the larvæ in turn consume the meat as they develop.

Treatment.—Protection of meats by the use of refrigeration or plastic covers. Affected meat must be cleaned and trimmed out, then washed in brine.

Stomoxys calcitrans.—The common stable fly is about the same size as the house fly, its thorax being grey, with four longitudinal dark stripes, whilst the abdomen is short and broad with three dark spots on each of the second and third segments. It lays its eggs, about twenty-five to fifty at a time, on moist decaying vegetable matter, and these hatch in from one to four days. Pupation takes place in the drier parts of the breeding material, and the complete life-cycle may cover about thirty days. The best months for the fly are those of the summer and autumn, and they may live for about a month. These flies are blood suckers and may attack any animal, whilst some varieties have been known to act as mechanical carriers of anthrax and of surra.

Control measures suggested are the destruction of their breeding places by the regular removal of moist bedding, waste food, decaying vegetable matter and refuse. The fly breeds in moist material, and spreading it out to dry will act as a

preventive. These flies are said to be very prevalent in the corn belt of North America.

Chrysomyia.—*Chrysomyia macellaria* and *C. bezziana* are said to cause the condition known as screw worms in cattle and other animals, including pigs, the former being found in North America and the latter in Southern Asia and Africa. *C. macellaria* has a green body with three longitudinal dark stripes on the thorax; the head is orange-brown. *C. bezziana* is medium sized, dark blue-green in colour, with four black stripes on the præscutum, the face being orange-yellow. The female fly deposits about 150 to 500 eggs at the edge of a wound or (*C. macellaria*) on a carcase. The larvæ hatch in twenty-four hours and mature in about three to six days, when they pupate in the ground. The pupal period may last from four days to several weeks, according to the temperature. The adult flies deposit their eggs in wounds, such as castration wounds, accidents, etc., and around the vulva of females, during the rainy weather chiefly. The maggots penetrate and liquefy the tissues, thus causing a deep lesion from which a foul-smelling liquid oozes out.

Treatment consists in thoroughly cleansing and disinfecting the wound, the destruction of maggots and animal carcases.

Glossina.—Various species of trypanosomes are transmitted by a variety of Glossina or tsetse flies, which are found chiefly in Central Africa and South Arabia. They are narrow-bodied, yellowish-brown flies, the female producing one larva at a time, when the latter is full grown and ready to pupate, the gestation period lasting about ten days, and it is believed the female can produce twelve larvæ. Some of these flies require shade and moisture, and may be killed by direct sunlight; others, such as the well-known *G. morsitans*, are active in a dry and warm climate. They fly low and are susceptible to light and shade, and are said to be attracted by any moving object. They feed on the blood of vertebrate animals, and most of them serve as intermediate hosts of various trypanosomes. *G. palpalis* transmits, amongst others, *Trypanosoma brucei*, *T. congolense* and *T. vivax*, causing nagana in animals. *G. morsitans* transmits the nagana trypanosomes, too, as also does *G. pallidipes*.

Control of these flies is very difficult, and includes such measures as bush clearing around settlements, roads, etc., so as to destroy shade which many of the flies require. Burning out of certain areas has also been tried where possible, as well as the destruction and control of big game on which many of the types feed. Ingenious traps for catching the flies are also extensively used. Artificial breeding places are created and the pupæ systematically destroyed. Antrycide is the latest drug used.

Beetles.—*Dermestes lardarius*, the larder or bacon beetle, does not affect the live pig, but pupates in some non-animal substance. The larvæ are found on bacon and hams. The adult beetle may be recognized by a whitish-coloured band over the upper half of the wing cases. This band has six small black spots, and the beetle itself is dark-brown in colour. The larva, when fully grown, is about 12 mm. long, covered with long, dark-brown hairs, and has dark-coloured bands on each segment. This gives it a dark hairy appearance. The last segment carries two hooked points. The pupa may be found in adjacent food material or wooden structures. The life-cycle of the beetle, from egg to adult, takes from two to four months.

FIG. 86.—LARVA OF *D. lardarius* (BACON BEETLE).

Dermestes vulpinus is closely related to the foregoing, and is similar in its habits. It has no white band on the wing cases, and its under surface is covered with yellowish hairs. This beetle has a white patch on each side of the thorax.

The larvæ of the bacon beetle attack other foodstuffs besides bacon and hams. On the latter the larvæ cause damage apart from their mere unsightly presence on foodstuff. The small size of the beetle (11 mm. long) and its flattened shape enables it to shelter in tiny crevices, feeding on the debris and dust which collect in cracks and under boards, etc. To

combat the beetles cleanliness is the first essential. Woodwork, boxes, shelves, floors, etc., should be scrubbed with hot water and plenty of soap so as to emulsify fats and oils. Fumigation is also effective, but often impossible to carry out. Baiting the beetles with cheese or fat and transferring the congregated beetles to boiling water can be done, the baits being placed in tins perforated with holes large enough to admit the beetles, but to keep out vermin. Bacon and hams can be stored hung in linen bags and periodically examined. Dusting the goods with pepper may prove useful. The portion of the ham affected with larvæ should be cut out and destroyed.

Anoplura.—Insects of this order are characterised by being wingless, with a body flattened dorso-ventrally. They include lice, both of the biting and sucking kind. The pig louse belongs to the family Hæmatopinidæ of the suborder Siphunculata, and is known as *Hæmatopinus suis*. It is a large louse, oval in shape, with a head, thorax and abdomen. The thorax carries three pairs of legs bearing claws. Eyes are absent. Lice eggs are yellowish in colour and are attached to the hairs of the host. They hatch out in from ten to twelve days or longer, and after passing through several stages the young louse reaches the adult stage in two or three weeks. Lice do not as a rule leave their host, and so infection is by actual contact. Lice are often found on pigs, especially on breeding sows and boars. They may be present in such numbers as to cause intense irritation to the host, leading to loss of condition and a dry scaly skin; the lack of condition caused in the host may so reduce the animal's vitality as to render it an easy victim to other diseases.

Treatment consists in washing down the pig with a solution of DDT, BHC, or derris powder, pyrethrum, or naphthalene in warm water with carbolized soap added. The wash should be repeated in about sixteen days. Oil has also been used in the form of paraffin oil soaked into a bag, and the bag tied round a scratching post. A wash with a mild solution of Dettol and some soft soap will also be found useful. Bedding in infected pens should be destroyed, and the pen walls disinfected and whitewashed.

Arachnida.—*Boophilus decoloratus*, or the blue tick, is common in South Africa. It is the tick which transmits

Piroplasma trautmanni of pigs in East Africa, as well as being responsible for the transmission of gall-sickness, red-water, and spirochætosis in other animals. It is a one-host tick requiring twenty-two days in the summer and thirty-eight days in winter for its development on the host. The female lays up to 2,500 eggs, which hatch in from three to six weeks. A 0·02 ml. per kg. body weight solution of Babesan (Diquinolylurea dimethosulphate) subcutaneously is used for treatment, and for control dipping at intervals of fourteen to twenty-one days.

Pig Mange—1. Sarcoptic Mange.—*Sarcoptes scabiei* (var. *suis*) is a tiny parasite almost circular in outline. The male has suckers with unjointed pedicles on the first two pairs of legs and also on the fourth pair, whilst the female has the suckers on the first two pairs of legs only. The third and fourth pairs of legs are short and do not project beyond the body margin. The female burrows into the skin and lays twenty to forty eggs in the tunnel so formed, the larvæ hatching out in from three to seven days. The larvæ have three pairs of legs, and this stage is followed by a nymph stage, the whole life-cycle taking about three weeks. The parasites live on the surface of the skin under scabs and crusts, and they pierce the skin to suck lymph; they may also feed on young epidermal cells. The irritation produced causes itching and scratching and rubbing, which only aggravate the condition and cause inflammation of the skin, with a discharging exudate which coagulates and forms crusts on the surface. There is also some proliferation of connective tissue, with keratinization, so that the skin becomes much thickened and wrinkled as well as bald, as the hair falls out owing to lack of nourishment. The animal affected is usually in poor condition.

Symptoms.—Pig mange generally affects badly nourished animals, where hygienic conditions are far from satisfactory. The affection may start along the back, behind the ears, or in very bad cases on any part of the body. The skin becomes bald, wrinkled, and covered with crusts, whilst in recent lesions there may be red papules or vesicles with some fresh exudate.

Treatment.—Diagnosis can be confirmed by the microscopical examination of skin scrapings. Even severely affected animals will respond to treatment which consists of the application of

an effective acaricide to the skin surface. A suspension of benzine hexachloride in one of its many forms is very often effective in one application. Small pigs are dipped thoroughly in the solution, while large pigs are hand-dressed or sprayed. An equally effective dressing described originally by Lamont, and investigated by Daykin and Lewis, was a saturated solution of magnesium sulphate applied gently by means of a brush. A more expensive but none-the-less effective dressing is an emulsion of benzyl benzoate. With all these preparations one

FIG. 87.—SARCOPTES SCABIEI—VAR. SUIS. (× 85)

or two applications at the most usually prove effective, but should always be accompanied by a thorough disinfection of the pig houses and appliances. Attention should also be paid to any object with which the infected pig has come in contact in runs or fields.

2. **Demodectic Mange.**—This type of mange is caused by the mite *Demodex phylloides*, a mite with a head, a thorax bearing four pairs of stumpy legs, and an elongated abdomen transversely striated on both dorsal and ventral surfaces.

These mites develop in the skin of the host; the larvæ

have three pairs of legs, and there are said to be three nymphal stages. The parasites are fairly resistant and may live off the host in moist surroundings for several days. Infection is by direct contact or by artificial means. As is usual in mange cases, it is the poor unthrifty type of animal that is generally affected.

Symptoms.—The Demodex parasite produces an inflammation of the hair follicles and sebaceous glands, with a chronic

FIG. 88.—SARCOPTIC MANGE—SECTION OF SKIN SHOWING MITES EMBEDDED IN THE EPITHELIUM.

thickening of the skin and loss of hair. Secondary invaders such as pyogenic organisms may result in abscess formation and the formation of numerous pustules. There may be no itchiness. The mites burrow deeper than the sarcoptic mite, and scrapings will have to be taken from deeper layers of the skin and from abscess material.

Treatment.—The infected place should be thoroughly cleansed and disinfected, and left empty for a while. Where

the infection is not extensive and the animal is considered worth treating, the part should be prepared for treatment as advised for sarcoptic mange, and the creosote liniment applied to the part. Bayer's Odylen, crude Dettol, and double B.P. strength phenol ointment may also be useful *in small patches.* Good food, with an adequate supply of minerals and vitamins, and a hygienic pen are most important if this condition is to be prevented, as there appears to be some resistance set up in well-fed pigs which seldom become infected with mange.

Worm Parasites

Many types of worm parasites affect pigs, such as the flat-, round- and tape-worms.

Trematodes.—These are flat, leaf-shaped worms, which develop through various stages in intermediate hosts, or direct. Where they pass through an intermediate host the latter is usually a snail of some type.

Fasciola hepatica (*Distomum hepaticum*), or the liver fluke of sheep and cattle, is often found parasitic in the liver of adult pigs which have access to pasture. The parasite is found practically all over the world. It is grey-brown in colour in the fresh liver, and is leaf-shaped with a ventral sucker. The parasite's eggs pass into the duodenum with the bile from the liver of the host, and they pass out with the fæces. Their development then depends a good deal upon the external temperature, and they may remain for a long time quiescent, hatching when conditions become favourable. The miracidium when hatched out of the egg can live freely for only a day or so, and it requires an intermediate host in the form of a snail (*Limnea truncatula* in Great Britain). In the snail the miracidium develops into the sporocyst, each of which has from five to eight rediæ. These leave the snail as cercariæ and settle on blades of grass just below water level. These cercariæ may encyst and become infective when swallowed by the pig or other animal. In the intestines of the host the cercariæ escape from their cysts and burrow into the intestinal wall, after which they migrate through the peritoneal cavity into the liver. Some may reach the liver via the bile ducts direct or through the blood stream. It is estimated that

the parasites enter the liver through the capsule about a week after being taken into the body, and they grow in the liver substance for about a month before reaching the bile ducts, where they are mature in two or three months from the time of infection. During their passage through the peritoneal cavity the young flukes may cause tiny hæmorrhages, and they destroy the liver tissue as they wander through. The adult flukes feed on liver tissue, bile ducts and blood, and they are said to produce a hæmolytic toxin, as well as causing an enormous enlargement of the bile ducts, with a great thickening due to the irritation. The increase in fibrous tissue may extend into the liver parenchyma, causing an extensive cirrhosis, whilst the bile ducts themselves are not only thickened, but the lumen is decreased.

Symptoms.—The chief symptom of fascioliasis in pigs is a general unthriftiness. In spite of good feeding the animal does not appear to thrive, and in advanced cases there may be emaciation. The abdomen becomes pendulous, visible mucous membranes may be pale or anæmic, or there may be some jaundice in a few cases, but that is not a very marked symptom in pigs, as, owing to their general unthriftiness, many are slaughtered off before the condition becomes too advanced. Some ascitic fluid may be found in the peritoneal cavity at a post-mortem examination, and the adult flukes may be seen on cutting the bile ducts. In some cases, although no adult flukes may be present, an extensive cirrhosis and enlargement of the bile ducts is found. On cutting into the bile ducts they may be lined with a greenish gritty substance which is difficult to cut. The eggs of the parasite may be found in the fæces; they have a yellow shell with an indistinct operculum, and the embryonic cells are also rather indistinct.

Treatment.—Sows may be given carbon tetrachloride in capsule form, with magnesium sulphate as a saline purgative to follow, with good feeding. Where there is an extensive infection, slaughter of the infected animals may be advisable. The sows should be removed from damp, low-lying wet pastures, and measures should be taken for the extermination of the snail acting as intermediate host, and without which the fluke cannot develop. A solution of copper sulphate 1 in 5,000,000 parts of water is enough to kill off the snails, and it can be

applied in the form of a 1 or 2 per cent. solution to pastures, or as a powder mixed with sand, and all pigs kept clear of such pastures for some time, or until there has been some heavy rainfall.

Fasciola buski.—This fluke is found in pigs in China and South-east Asia. It is a large, oval-shaped fluke worm. Its intermediate host is a snail of the Planorbis and Segmentina species. The parasite is found attached to the intestinal mucosa of the pig and man, and may cause inflammation in severe cases, with diarrhœa and ascites.

Treatment is by the administration of carbon tetrachloride, and the hygienic disposal of fæces and human nightsoil. The cercariæ attach themselves to certain water plants which are eaten raw. The scalding or boiling of such plants before use is advisable for the destruction of the parasite.

Dricocœlium dentriticum (*D. lanceolatum*).—This is a small fluke with a rather elongated body, being narrow anteriorly. It is found in Europe and various other parts of the world, and a snail again acts as intermediate host. The flukes penetrate the finer branches of the bile ducts and set up a cirrhosis of the liver. They are sometimes found with *Fasciola hepatica*, and unless there is a great infection the symptoms produced are not so severe as those produced by the latter. Carbon tetrachloride is not so effective against this parasite, and measures must be taken against the snails, as in the case of *F. hepatica*.

Opistorchis felinus.—This fluke is a small medium-sized worm with a flattened translucent body, narrow anteriorly. It is found in the bile ducts, intestine, gall-bladder and pancreatic duct of pigs and other animals, including man, in Europe, Asia and Canada, but not in Great Britain. The worm has a reddish colour when fresh, and the eggs are of a brown tint. The intermediate host is a snail (*Bithynia leachi*), and the cercariæ are found in several kinds of fish. Infection occurs through the host eating raw infected fish. They cause cirrhosis of the liver, with its attendant symptoms, but unless infection is heavy there may be few symptoms shown. Ascites, jaundice, diarrhœa, and in man and cats several cases of carcinomata in the liver and pancreas, have been ascribed as being due to this parasite. For treatment against the worm gentian violet and neoantimosan (Fuadin) have been used.

Other species of Opistorchis are also found in pigs.

Clonorchis sinensis is a parasite resembling *O. felinus*, found in the bile ducts and occasionally the pancreatic ducts of pigs and other animals, as well as man, in Japan and South-east Asia. A species of snail acts as first intermediate host, and

FIG. 89.—PART OF A SOW'S LIVER WITH THE BILE DUCT OPENED UP TO SHOW *Fasciola hepatica* PRESENT.

fresh-water fish as second host. Infection occurs through eating raw infected fish.

The *symptoms* set up resemble those caused by other fluke worms, and the *treatment* consists of giving gentian violet or sodium antimony tartrate. Carbon tetrachloride has also been used, and neoantimosan or stibophen. Fish should be thoroughly cooked before feeding, and fæces and nightsoil treated with ammonium sulphate to kill the eggs.

Echinochasmus perfoliatus belongs to a class of somewhat elongated flukes whose oral sucker is surrounded by a collar of large spines in single or double row. This particular worm is found in the intestine of the pig, as well as of the dog, cat and fox, in Europe and Asia. The primary intermediate host is believed to be a snail, with fresh-water fish as the second intermediary. The parasite sets up a severe enteritis in the host's body.

Treatment consists in giving carbon tetrachloride or tetrachloroethylene. Great care must be exercised in using the former in view of its special toxicity for pigs.

Metagonimus yokogawai is a small trematode, wider posteriorly than anteriorly, and it is found in the small intestine of the pig as well as certain other animals and man in the Balkans and Eastern Asia. Snails of the genus Melania are the first intermediate hosts, and several species of fresh-water fish act as second intermediate hosts. The parasites are believed to be of low pathogenicity, but may set up some diarrhœa.

Treatment is as for the other species of flukes.

Paragonimus westermani, the lung fluke, is a fluke having a fleshy body, concave ventrally and convex dorsally, with a spiny cuticle. The parasite is found in the lungs, and sometimes in the brain, spinal cord and other organs of the pig, other animals and man. Parasites of this type are found in America, China, Japan, Malay States and Africa. The eggs are laid in the cysts in which the parasites live, and they escape into the mucus, which is swallowed; thus they pass out with the fæces. A snail acts as first intermediate host, and a species of crustacea as second host. The final host becomes infected through eating the crustacea or drinking water infected with the metacercariæ. The young fluke liberated in the intestine penetrates the wall and wanders through the peritoneal cavity and diaphragm to the lungs, entering via the pleura. It encysts in the bronchioles and develops into an adult worm, the cysts usually containing two parasites, eggs and purulent fluid. They set up pseudotuberculous lesions in the lungs, and are not of great importance unless they migrate to other sites such as the brain, or the mucosa or skin, where they may form ulcers.

Treatment is not very satisfactory. Antimony potassium tartrate has been used for human cases.

Paragonimus kellicotti is similar to the foregoing parasite, and has been found in the pig in America, and in cats in South Africa and tigers in the Malay States. Its life-history and treatment, etc., are similar to those of *P. westermani.*

Gastrodiscus ægyptiacus belongs to a family of trematodes having a body that is somewhat thick and circular in transverse section; it occurs in the intestines, large and small, of pigs, equines, and warthogs in Africa and India. It is of a pink colour, the anterior part of the body being cylindrical and the posterior part saucer-shaped. Little is known as to its pathogenicity. In Egypt the intermediate host is believed to be a snail of the genus Cleopatra, the cercariæ encysting in water.

The *treatment* is usually by the use of carbon tetrachloride or tetrachlorethylene.

Schistosoma japonicum is an elongated, unisexual trematode, the female being carried by the male in the ventral groove. It is found in the portal and mesenteric blood vessels of the pig, other animals and man in Africa and the Far East. The female lays eggs in the capillaries of the mucosa or submucosa of the intestine. They are then passed out with the fæces, and the intermediate host is a snail of the Oncomelania genus. The host is infected from water containing the cerceriæ, which penetrate the skin and gain access to the blood circulation. In severe infections the skin penetration causes a dermatitis, and even pneumonia; kidney hæmorrhages and liver congestion may also be caused, but the most important lesions are caused by the masses of eggs in the intestinal wall. These become surrounded by inflammatory tissue and leucocytes, giving rise to an abscess, which may eventually burst, discharging its contents into the lumen of the intestine and causing diarrhœa. Abscesses may also form in the liver, and may become encapsulated and cause cirrhosis and ascites. Other organs such as the spleen and also the mesenteric lymph glands may be infected, and an anæmia may be set up as the parasites feed on the blood. Lesions may occur in the brain and central nervous system. The most marked post-mortem lesions are thickening of the intestinal wall, some ascites,

anæmia and emaciation, cirrhosis of the liver, and a thickening of the portal veins. There may also be an abnormal amount of connective tissue in the spleen and mesenteric lymph glands, and a pigmentation of the liver and spleen due to regurgitation of blood pigment by the feeding parasite. The parasite should be searched for whilst the intestine and mesentery are still attached to one another. Eggs may also be found in the fæces.

Treatment.—Sodium antimony tartrate in small doses given intravenously is said to give the best results.

Cestodes.—These are flat, elongated endoparasitic worms or tapeworms without a body cavity, the head or scolex usually having suckers and hooks, the body consisting of numerous segments, each of which contains one or two sets of male and female reproductive cells. These worms vary in size from a few millimetres to many metres in length. The eggs usually hatch after being swallowed by an intermediate host, and the embryo penetrates the intestinal wall to reach a part of the body suitable for further development. It then grows into a cyst, with an outer cuticle and inner germinal layer, and containing a cavity filled with fluid—the hydatid cyst. Here it develops one or more heads on its wall or in brood capsules. When the hooks and suckers on the head are sufficiently developed the hydatid is ready for a further stage. The hydatid is transferred to the final host when the latter consumes the intermediate host or its fæces or contaminated matter. In the final host the egg sheds the cystic covering and attaches itself by suckers and hooks to the intestinal wall, where it develops segments which may eventually lead to a tapeworm many yards in length. Each segment as it is shed in the fæces is capable of forming a new cyst, and so repeating the cycle.

The hydatid cysts may be classified as follows according to Mönnig:

Cysticercus: A hydatid with a large vesicle containing one head, usually found in vertebrates.

Cysticercoid: A small vesicle almost without a cavity and containing one head, found in invertebrates.

Cercocystis: A certicercoid with a tail-like appendage.

Multiceps: A large cyst with a number of heads developing on the wall.

Echinococcus: A large cyst with brood capsules in which heads develop.

Dithyridium: An elongated larva with a solid body into which the head is invaginated.

Tænia solium, affecting man, is of importance in that the hydatid stage, *Cysticercus cellulosæ*, is found in the pig and dog, but the parasite is very rare in British pigs. In the pig it is the cause of measles or measly pork in the muscular tissues. The eggs, when eaten by pigs under six months of age, are hatched in the intestine, and the embryo penetrates the gut wall, reaching the blood circulation, by which it may be carried all over the body. In the muscles and organs the embryos develop the intermediate or hydatid stage, the cysticerci, and human beings may be infected by eating infected pig flesh.

In the pig the cysticerci require about ten weeks to complete their development, and affected animals show no clinical symptoms as a rule, the parasites being found in the carcase after slaughter.

Post mortem.—The cysticerci may die and undergo caseation and calcification, when they may be found as white spots studding the heart muscles. They are also found in the abdominal muscles; lumbar, intercostal, cervical, pectoral, and adductor muscles of the thigh; the tongue; masseter muscles; the brain, lymphatic glands and panniculus adiposus; the shoulder and deep thigh muscles, as well as occasionally in the liver. In abattoirs where this parasite is looked for the peritoneal fat is lifted and the abdominal muscles exposed, after the carcase has first been split down the backbone into two sides. The size of the cysticerci will vary according to their development at the time the pig is slaughtered. These variations according to Gerlach are:

At twenty days the cysticercus is the size of a pin's head, and appears as a delicate transparent vesicle, with an opaque spot showing the position of the head.

At forty days the cyst wall is present and the parasite is about the size of a hemp seed, with a distinct head, hooklets and suckers.

At sixty days the cyst is the size of a pea, the head showing as a whitish projection.

At 110 days the neck is developed and segmentation is distinct, the head being invaginated.

The muscles examined for cysticerci are usually the muscles of the thigh, abdomen, diaphragm, cervical, intercostal, as well as the heart, tongue and larynx. Meat containing this parasite is not allowed to be used as human food, owing to the fact that the tapeworm of which the cysticercus is a stage is found in man. It is said that the cysticerci can sometimes be felt under the tongue in the live pig.

Morgan described the method of diagnosis adopted by Venezuelans for *Cysticercus cellulosæ* in their pigs. He said that it is an old custom in Venezuela, when selling pigs for the slaughter-house, that the one who sells must stand the loss when the carcase is highly infected with this parasite and totally condemned. The pig breeders and merchants there are experts at the diagnosis of this condition. They cast each pig on its back over, say, a motor-tyre laid on the ground, and by means of a piece of wood about an inch thick the pig's mouth is kept open and the tongue carefully examined all around for bladders or cysts, which they call huevitos (little eggs). The mucous membranes of the eyes are also carefully examined, as the cysts are often found here. Not only are they detected, but are often pierced with the point of a long needle and the contents withdrawn so as to deceive the next buyer. Very often the eyes of infected pigs at certain periods are bloodshot, and this is taken as a sure symptom of cysticercosis. Morgan considered it important that students should be warned that the usual textbook sites are not the only important places to look for the parasite, but that the deep muscles, especially of the thigh, are often infected, and that freedom from infection in the tongue, masseters, heart, etc., does not necessarily indicate that the carcase itself is completely free from infection. Pork infected with this condition and kept in freezing rooms for a week is rendered sterile. Venezuelan pigs kept around towns act as scavengers, and the percentage of cysticercosis is thus high in that country.

Treatment of a medicinal kind is useless for the destruction of the parasite in the flesh, and where this condition is usually

found, such as in certain European and American countries, preventive measures should be adopted such as keeping pigs away from all human excreta and the regular examination of pig attendants for *T. solium.*

Tænia hydatigena (otherwise known as *T. marginata*) is found in carnivores and some vermin, and is of importance in that the intermediate stage is *Cysticercus tenuicollis,* which infects pigs as well as cattle and sheep. The embryos hatch in the intestine of the pig and reach the liver through the blood

FIG. 90.—HYDATID CYSTS (*Echinococcus veterinorum*), IN THE LIVER OF A PIG, CONTRASTED WITH A NORMAL LIVER.

circulation. They may be transported elsewhere by the blood, but the parasite generally breaks out through the liver tissue by burrowing small channels to the surface of the organ, when it enters the peritoneal cavity after a stage of about three or four weeks' migration in all. The adult cysticercus is found in the peritoneal cavity, chiefly in the omentum, mesentery and on the liver, in the form of bladder-like cysts with a slender neck and a head armed with a double circle of larger and smaller hooklets. The parasite may set up lesions of peritonitis, and when the lungs are invaded it may cause

pleurisy and bronchopneumonia. In very young pigs an extensive invasion may lead to hæmorrhage from the liver, resulting in the death of the pig. The parasite in its migration through the liver leaves little dark red streaks showing its track through the organ.

Symptoms.—In a mild invasion no symptoms may be present, and the condition is not discovered until the animal has been slaughtered. It is a fairly common condition in British pigs, but as a rule the parasites are few in number, and are generally attached to the omentum. In an extensive infection symptoms of peritonitis, pleurisy and pneumonia may be shown.

Treatment.—Medicinal treatment for the destruction of the cysticerci is useless, and the animals are best slaughtered and the parasites collected and destroyed. Preventive measures should be carried out by the treatment of dogs for tapeworm, and by preventing dogs from coming in contact with pigs.

Echinococcus granulosus is a tapeworm found in the dog and other carnivores, and the intermediate stage is often found in the pig, as well as in cattle and sheep, in the form of the hydatid known as *Echinococcus veterinorum.* The eggs after ingestion by the pig hatch in the intestine and the embryos migrate via the blood stream to various organs, notably to the liver and lungs. The echinococcus is a large, thick-cuticled hydatid, and about five to six months after infection the germinal layer of the hydatid forms numerous brood capsules, and each of these vesicles may contain up to forty scolices. The echinococcus is frequently sterile, and is believed to be more fertile in the sheep than any other animal. It may be found in any part of the pig's carcase or organs, but is generally seen in the substance of the lungs and liver, and may give rise to a pneumonia and an extensive cirrhosis of the liver, with an accompanying ascites. The cysts may sometimes be found caseating or in a calcified form, and the parasite affects old pigs as well as young.

It is very rare that any symptoms pointing to echinococcus infection are diagnosed in the living pig, and the condition is only discovered after the slaughter of the animal. No method of medicinal treatment is known, and it is dangerous to puncture

the cysts in the living animal, as this may release some of the scolices to start a new infection. Dogs should be treated for tapeworms, and prevented from coming into contact with pigs.

Nematodes.—These are unsegmented worms, cylindrical and elongated in shape, and their body may contain a fluid which may be harmful to the host if the worm is digested after

FIG. 91.—*Echinococcus veterinorum* CYSTS IN A PIG'S LIVER

having died in the intestine. The sexes are usually separate, but some hermaphrodite forms also occur. The females are very prolific and may lay thousands of eggs per day; these eggs, varying in shape and size, may divide into two, and then again subdivide repeatedly. The embryo may pass through a few different stages before the larva is ready to hatch. Some of these Nematoda have no intermediate host

but many do require passage through another host before reaching the final adult stage. Although most of these worms are intestinal parasites, yet when they enter the host many of them migrate through the body to various organs, causing damage on the way, before they eventually settle in the intestine.

Ascaris lumbricoides (*A. suis*).—This worm is the common

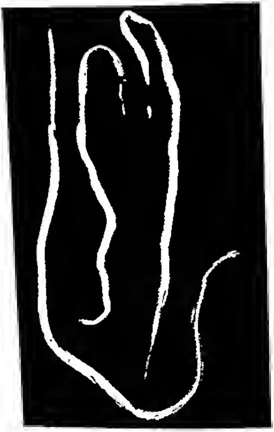

FIG. 92.—*Ascaris lumbricoides* (*A. suis*).

roundworm of the pig, and it is also found in man and apes. It is a long worm; the females may be over a foot long, and the males about 10 inches in length, the narrow end being the head end. It is said that the female ascaris may lay as many as 200,000 eggs per day, and these may be passed in the fæces of the host to develop to the infective stage in about ten days or so, according to the temperature. The eggs are very

resistant to drying and freezing, as well as to chemicals, and they may remain viable for several years. They are killed in a few weeks if exposed to hot sunlight, and the eggs hatch as a rule in the pig's intestine. Infection is through ingestion of the eggs with food and water, and in the case of the sucking pig infection comes from the contaminated skin of the sow.

When the eggs are swallowed by the pig they hatch out in the intestine, and the larvæ burrow into the intestinal wall

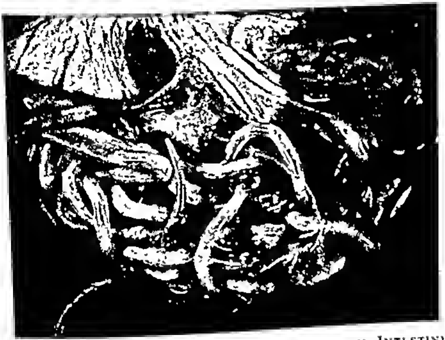

FIG. 93.—*Ascaris lumbricoides* INFESTATION OF THE INTESTINE.

and pass into the blood stream. (See Cirrhosis of the Liver.) From the liver the parasite passes via the blood stream into the lungs. Here the parasite is arrested in the capillaries, but some may pass through and be carried by the circulating blood to other organs, and in the pregnant sow it is said that they may in this way infect the fœtus. The larvæ in the lung capillaries may escape into the alveoli and pass up the trachea to the pharynx. They are then swallowed and pass down the œsophagus into the stomach, and then into the intestine once more, where they grow into the adult worm commonly seen in the pig after slaughter.

It is known that infective eggs of parasites like *A. suis* may hatch in the intestines of other animals, and the larvæ

may migrate through the lungs in animals other than the normal host. Owing to that behaviour of the parasite and to the fact that *A. suis* is regarded as a mere variety, or even as being identical with *A. lumbricoides*, which infects man, the danger of human infection from the pig is apparent.

Symptoms.—Young pigs and pigs up to about six months old or so are usually affected, and symptoms will depend largely upon the degree of infection. Where only a few worms are present there may be no clinical symptoms shown, but in heavy infestations, and where the worms enter the stomach, there may be vomiting, impaction of the bowel owing to obstruction of the intestinal lumen by masses of worms, jaundice following an invasion of the bile ducts, anæmia, emaciation, and the pig will often have a pendulous abdomen. The presence of larvæ in the lungs sets up pneumonia, and there may be some coughing, with some exudation. Growth is stunted and the animal appears very unthrifty. If there is abdominal pain, the animal will lie down and creep under the straw or litter, and young pigs may show nervous symptoms, with convulsions.

Post mortem.—Where there has been a heavy infection, much damage may have been caused by the migrating larvæ, such as liver and kidney hæmorrhages, and similar lesions in the bronchioles and alveoli of the lungs, with some lobar pneumonia. Petechial hæmorrhages in the intestines are caused by the adult worms Ulceration and penetration of the bowel wall is not unknown, followed by a peritonitis. Dead ascarids, when digested by the host, liberate some harmful substances.

The larvæ may be found in the sputum, and eggs may be found in the fæces or dirt and soil on which the pigs are kept, whilst adult worms are also to be found in the fæces. Where only male worms are harboured there will be no eggs, and many unfertile eggs are passed where female worms only are harboured.

Treatment. — Vermicides such as oil of chenopodium 1 drachm per 100 lb. live weight in castor oil, hexylresorcinol in capsular or pill form, santonin in 2- to 10-grain doses, according to the size of the pig, have also been extensively used, but repeated small doses are said to be more effective than one large dose. Treatment against lung as well as bowel worms can be

combined by the use of cyanacethydrazide with piperazine preparations. Piperazine and carbon disulphide are used to attack both ascarids and *Œsophagostomum dentatum*. Phenothiazine is toxic for pigs and must be used with care. Sodium fluoride is given in a dry feed, but the dose must not exceed from 0·1 to 0·15 gramme per lb. body weight. Sodium fluoride can also be poisonous if the dose is exceeded or is given in wet food. Other treatments are based on the piperazine compounds which are quite effective and comparatively safe.

As the worm eggs may live for a long time, it is advisable to transfer the treated pigs to a clean pen within ten days, before any of the eggs passed can become infective. The pens should be thoroughly cleaned out, disinfected, and scrubbed with boiling water and soda. Fowls, dogs, flies, etc., should be prevented from contaminating pig food, and poultry and dogs should especially be kept away from pigs. In the MacLean County system devised by Ransom in America the pregnant sow, just prior to farrowing, is first treated for worms and then she is thoroughly washed and scrubbed so as to remove any eggs adhering to the dirt on the skin. She is then placed in a clean farrowing pen which has also been prepared by washing out and scrubbing with boiling water and soda. About ten days after farrowing the sow and litter are carted off to a clean field planted with some crop such as rape. This system is said to give excellent results in the control and prevention of ascarid infection.

Strongyloides.—*Strongyloides westeri* is found in the small intestine of the pig, as also are *Strongyloides ransomi* and *Strongyloides suis*. These worms all live as parasites in the intestine of the pig and some other animals, and are very small, varying from about 4 to 9 mm. in length, and are found penetrating the intestinal mucosa. They are not very pathogenic, and do not appear to set up any clinical symptoms unless the infection is very heavy, when there is some unthriftiness in the host, as well as anæmia, weakness and stunted growth. The eggs or larvæ can be demonstrated in the fæces.

Treatment.—Modern vermifugal treatment should be applied and clean dry pens provided for the pigs, the bedding being changed fairly frequently.

Trichinosis.—This condition in pigs is caused by the *Trichinella spiralis*, a worm also found in the small intestine of man and rats, as well as some other mammals. It is a tiny parasite from 1 to 4 mm. long, the female being longer than the male. The eggs when laid contain the fully developed embryo. Copulation takes place in the intestine, after which the male dies and the female penetrates to the glands of Lieberkühn until it reaches the lymph spaces. Here the eggs are laid and immediately hatched. The lymph and

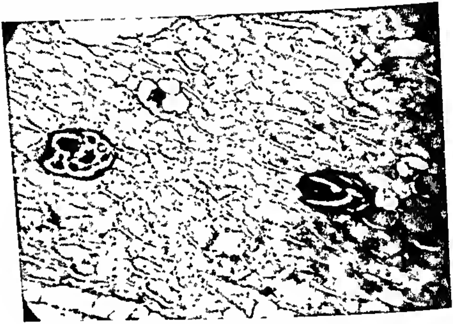

FIG. 94.—*Trichinella spiralis* INFESTATION OF MUSCLE.

blood distribute the larvæ all over the body to the muscles. They leave the muscular capillaries and enter the connective tissue, from which they pass into the sarcolemma. Here they burrow until they reach the aponeurosis and tendons. The first trichinæ appear in the muscles about a week after infection, and they are full grown in about three weeks, when they appear curled in the sarcolemma. A capsule is formed and completely surrounds the parasite in about three months. Trichinæ have been known to live and to be active for from ten to twenty years. Calcification may take place in the capsule, leaving the actual worm intact, but later on the

parasite itself may become calcified. The parasite is found in striped muscle as a rule, and soon dies if it invades other parts of the body. It seems to prefer muscles with a poor glycogen supply, such as the masseters, to those rich in sugar; thus some muscles or groups of muscles are more often infected than others, and those principally affected are the diaphragmatic pillars and remainder of the diaphragm, the lingual and laryngeal muscles, the abdominal and intercostal muscles, in that order of preference.

Trichinella spiralis is found in pigs both in Europe and America, but not hitherto in British pigs, although some inspection for trichinellæ is carried out in certain English abattoirs. As pig flesh is always cooked before consumption in England, the danger from eating infected pork is not so great here as on the Continent, where thin slices of raw meat may be served up for human consumption.

Symptoms.—As a rule there are few symptoms observed in the live pig beyond some rheumaticky pains, when there is a heavy invasion of the muscle fibres, causing some stiffness. There may also be some diarrhœa, œdema, hyperpyrexia, and emaciation, with dyspnœa.

Post mortem.—Diagnosis of the condition is usually made after slaughter by removing small pieces of suspected muscles and examining microscopically, or by means of an epidiascope. For microscopic examination the small pieces of muscle are pressed between two slides and examined by a low power, when the parasites can be seen as oval encapsulated forms with the spiral worm inside. Smoked ham should be first treated with dilute acetic acid before an examination is made, otherwise it may be impossible to detect the parasites. The specimens for examination are usually taken from the pillars of the diaphragm near the tendinous portion, or, failing that, from the costal and abdominal muscles. Of late years the use of the microscope for Trichinella examination has been superseded by the epidiascope or trichinoscope in abattoirs where a routine examination for the parasite is made. By this means a picture of the suspected preparation is projected on a screen, and the parasite can thus be easily detected in the muscle fibres.

Treatment.—There is no known method of satisfactory

treatment. Rats are said to act as carriers of Trichinella, and pigs may be infected from food contaminated by rats. Destruction of rats should therefore be carried out in order to reduce the possibility of pig infection. Pigs have also been infected from rat-contaminated material from knackeries. The thorough cooking and boiling of pork meat should prevent any human infection. Salting alone does not destroy the parasite. In America uncooked garbage-fed pigs show a high percentage of infection, and all garbage fed to pigs should thus be well cooked prior to feeding, and the feeding of raw pork scraps discontinued.

Trichuris trichiura.—This parasite is also known as *T. suis*, *T. apri* and *T. dispar*. It is found in the pig and in man, and belongs to the whip worm genus, the anterior part of the body being long and slender like a whip, the posterior part being the whip stock. The worm is fairly universal, and its eggs develop in the open, becoming infective in about three weeks' time under favourable conditions. Infection is acquired by ingestion of the eggs, which hatch out in the intestine. The larvæ pass on to the cæcum, where they grow to the adult stage, and are found with their anterior ends deeply embedded in the mucosa The eggs are passed out and may be detected in the fæces of the host. They seldom give rise to clinical symptoms, but in severe infections they may cause some unthriftiness.

Treatment is rarely called for, but drugs like hexylresorcinol, mercurochrome, and Spirocid have been used in som animals. In sheep, enemata containing benzene have bee used, after a preliminary purgation.

Bourgelatia diducta.—This worm has been found in th cæcum and colon of pigs in India and the Far East, but littl is known as to its effects.

Œsophagostomum dentatum.—Several species of this wor have been found in the colon of pigs. They are small worn from 8 to 14 mm. long, and form nodules in the intestine rendering them unsuitable for use as sausage casings. The seldom cause any clinical symptoms, and are not found a rule except at post-mortem examinations. Hexylresorcin in 4-gramme doses is used against this worm and in exper mentally infected pigs a daily dose of 3·7 ml. per pig of a dilu

aqueous solution of ferrous and copper sulphate is said to be beneficial. A stable compound of piperazine and carbon disulphide given in wet or dry food will remove both *A. lumbricoides* and *O. dentatum*.

Stephanurus dentatus.—This is the kidney worm of pigs, and is found in the kidney pelvis, the walls of the ureters, and occasionally in the liver and other organs, as well as in the spinal canal. It is found in tropical and subtropical countries, and is from 20 to 45 mm. long. The adult worms are in cysts, and the eggs are passed out with the urine of the host. The eggs and larvæ are killed by freezing and drying, but infective larvæ can live in moist surroundings up to five months. The pig is infected by ingestion or through the skin, and the parasite reaches the wall of the stomach or, if infection is via the skin, the abdominal muscles. From here it passes to the liver, and after migrating through the liver tissue penetrates the capsule and enters the peritoneal cavity. It then penetrates the walls of the ureter and lives in cysts communicating with the lumen. Some remain in the lungs during their passage through the body, and others may penetrate the portal vessels and cause thrombi. They may also be found in the spleen and in the psoas muscles, as well as in other abdominal organs.

Infection via the skin may cause nodules in the cutaneous tissues, with some œdema and enlargement of the superficial lymph glands. Bacterial infection may occur, with the production of abscesses, whilst cirrhosis and adhesions may be found internally.

According to Morgan, this worm is very prevalent in Venezuelan pigs from the plains kept far from dwelling-houses. The parasite is found not only in and around the kidney, but in other organs as well.

Symptoms.—Morgan gives the symptoms observed in infected pigs as paralysis of the hindquarters, especially in heavy infections and after a long journey.

Post mortem.—Decomposition is rapid in animals affected with the worm and in those pigs that have died from heavy infestations. Cutaneous nodules may be found, and peritonitis, with adhesions of the abdominal organs. Cysts or abscesses may be present in the liver and lungs, with a venous

hyperæmia of the liver, kidneys, and mesenteric lymph glands. The liver surface may be scarred from tracks made by the parasite. Cirrhosis and ascites may also be present, as well as thrombi in the hepatic vessels. There may be some hypertrophy of the perirenal tissues, and the worms are found in and around the kidneys and ureters. The eggs may be found in the fæces.

Treatment.—No satisfactory treatment is known, but carbon tetrachloride is believed to be effective against the parasite when in the liver. Preventive treatment as carried out in America against the *A. suis* is said to be equally effective against this worm. Spraying the ground with a 10 per cent. solution of copper sulphate is said to be effective in destroying the larvæ, and the draining of all moist and muddy shady spots. Pigs should be kept in pens with concrete floors, and these pens should be sprayed out once weekly.

Ancylostoma duodenale.—This is one of the hookworms found in tropical and subtropical countries, and it has been found in the pig as well as in man. The parasite's life-history is somewhat similar to that of Ascaris, especially in the migration of the larvæ throughout the host's body.

Necator americanus.—*N. suillus* is regarded as the same worm as *N. americanus*. It is a hookworm which is sometimes found in pigs in tropical countries, but is of more importance as a human parasite.

Globocephalus urosubulates.—Several types of this worm are found in the small intestine of the pig in Europe, America, Africa and the Far East. It is a small worm about 4 to 8 mm. long, and very little appears to be known about its pathological effects, if any.

Trichostrongylus instabilis has been found in the duodenum of the pig; it is a small worm from 4 to 7 mm. long, slender, and of a pale-brownish colour. The eggs are passed out in the fæces of the pig. Infection is by ingestion, and the larvæ penetrate the mucosa of the intestine, later returning as adult worms to the surface of the mucous membrane. Pigs, unless heavily infected, show few symptoms except those of unthriftiness, and treatment is seldom called for, but small doses of carbon tetrachloride in capsular form may prove useful.

Hyostrongylus rubidus is commonly found in the stomach of the pig. It is a slender reddish worm from 4 to 9 mm. long. Infection is believed to occur by ingestion with food, etc., and the parasites burrow into the gastric mucosa, where they feed by blood sucking. There is some indication that this species causes more trouble than is generally realized, particularly in sows.

Symptoms are seldom shown unless there is a very heavy infection, when some gastritis may be set up, great loss of condition, diarrhœa, and inco-ordination of movement, with weakness in the hindquarters. As a rule the parasites are not present in sufficient numbers to cause such ill-effects, and they may often be seen at a post-mortem examination when the pig's stomach is opened. Eggs can be found in the fæces.

Treatment.—Success is claimed for the use of carbon disulphide given in capsules or by stomach tube in doses of 2 to 2½ fluid drachms per 100 lb. body weight after 1-2 days' fasting. Phenothiazine in carefully calculated and administered doses is also effective.

Mecistocirrus digitatus is found in the pig's stomach in Eastern countries. The worm is about 40 mm. long, and the larvæ burrow into the mucosa of the stomach, whilst the adult worms attack the surface of the membrane, which they pierce with the buccal lancet in order to suck blood. A heavy infestation may result in some anæmia and unthriftiness in affected pigs.

Treatment is not very satisfactory. Carbon tetrachloride and copper sulphate have been tried, but in heavy infections slaughter may be the best policy.

Ollulanus tricuspis is also found in the stomach of the pig, cat and fox, and is fairly common in Scotland and Wales. It is a very small worm, up to 1 mm. long, the tail of the female ending in three or more short cusps. The larvæ develop in the uterus until their third stage. Infection is by ingestion. An extensive infection may set up a chronic catarrhal gastritis with some unthriftiness and emaciation.

No specific treatment is known, but the various drugs mentioned for the treatment of stomach-worm infections might be tried.

Metastrongylosis.—This condition is caused by lung worms, and one of the worms found in the lungs of pigs is *Metastrongylus apri* or *M. elongatus*, a slender pale worm, the males being about 25 mm. long and the females up to 50 mm. or more in length. They are parasites of the bronchioles and are widely distributed.

The eggs hatch in the bronchi or in the intestines of the host, and are passed out in the fæces. They have to pass through Lumbricus (the earth worm) before they reach the infective stage. They develop in the earth worm and are liberated if the earth worm is injured or dies, and pigs become infected by eating lumbricus or material contaminated with infective larvæ. In the pig the larvæ pass through the intestinal wall and are carried by the lymph to the mesenteric glands, where they undergo another moult, and then pass again with the lymph and blood stream into the lungs, where they grow to the adult stage.

The parasites are quite common in the lungs of pigs, and do not as a rule cause much harm. In a severe infection they may set up a verminous bronchitis, loss of condition, and retarded growth. Larvæ may be found in the pig's fæces, and at a post-mortem examination the worms may be squeezed out of the bronchioles of the lungs when they are cut through. Pale triangular areas may be found on the lung surface along the posterior border, and there may be some small nodules in the lungs caused by the parasite.

Treatment is now available by means of which lungworms as well as ascarids in the bowels can be eliminated from the body. A combination of cyanacethydrazide and piperazine is used. Good feeding and fattening the pigs on a Scandinavian principle contribute to the eradication of these parasites, as the pigs under that system are fattened indoors in buildings with concrete floors, where contact with the earth worm is impossible.

M. pudendotectus (*M. brevivaginatus*), or *Chœrostrongylus pudendotectus*, is a somewbat smaller worm than *M. apri*, and is found in a similar situation in the pig's body. It is fairly widely distributed throughout the world.

M. salmi is a similar type of worm found in pigs in America, China, and parts of Africa, and causes a similar condition to that set up by *M. apri*.

Ascarops strongylina (*Arduenna strongylina*) is a worm about 10 to 20 mm. long found in the stomach of the pig. The intermediate hosts are beetles (sp. Aphodius, Onthophagus and Gymnopleurus), and pigs become infected through eating the infected beetles.

Ascarops dentata is another worm of the same type, but somewhat larger than *A. strongylina*, and is found in pigs in the Eastern Archipelago.

Physocephalus sexalatus is also found in the stomach of the pig, the intermediate hosts being species of beetles, and infection being by ingestion.

The Ascarops and Physocephalus worms are common stomach worms in pigs, and if infection is heavy they may set up gastritis in young pigs, but normally a healthy pig may harbour these parasites without showing any clinical symptoms.

Simondsia paradoxa is found in small cysts in the stomach wall of pigs. The male worm may live free in the stomach, whilst the female has the posterior part of the body lodged in a small cyst in the stomach wall, with the anterior part protruding.

Gongylonema pulchrum.—This worm, or *G. scutatum* as it is often called, is found in the œsophagus embedded in the mucous membrane. The intermediate hosts are various species of beetles, and pigs are infected by eating such beetles. It is believed that the larvæ reach the œsophagus from the pig's stomach through the blood stream. The worm does not set up any clinical symptoms in the pig as far as is known.

Gnathostoma hispidum is a worm about 2 inches long occurring in the pig's stomach, but the young worms may migrate through the abdominal organs, especially the liver, where they may set up a cirrhosis if the invasion is at all extensive. In the stomach the worms may set up some gastritis in weakly pigs.

Setaria bernardi is a parasitic worm of the peritoneal cavity in pigs, and does not appear to have much importance.

Macracanthorhynchus hirudinaceus.—The worm is more commonly known as *Echinorhynchus gigas*, and is found in the small intestine of the pig. The female worm is sometimes over a foot long, and the male about 9 inches. It is a rather

thick worm, with its cuticle transversely wrinkled, and is of a pale reddish tint. The eggs passed in the pig's fæces hatch in the larvæ of beetles, such as dung beetles and water beetles, and become encysted in the beetle's body. Pigs are infected by eating the grubs or the adult beetles harbouring the worm in its infective stage. The adult worm in the pig's intestine may cause deep penetration of the intestinal wall and set up peritonitis, especially in severe infestations. The parasite's eggs may be found in the pig's fæces, and treatment consists in giving vermicides such as carbon tetrachloride, or a mixture of that drug and nicotine sulphate. Chenopodium does not seem to have as good an effect in the treatment of this parasite as it does when used against *A. suis.*

Animal Parasites which may affect Pigs

PROTOZOA

Entamœba suis.
Coccidioides immitis.
Eimeria zurni.
Eimeria debliecki.
Eimeria perminuta.
Eimeria scabra.
Balantidium coli.
Trypanosoma brucei.
Trypanosoma brucei.
Trypanosoma congolense.
Trypanosoma vivax.
Trypanosoma simiæ.
Trypanosoma melophagium.

INSECTS

Flies:

Musca domestica.
Chrysomyia macellaria.

Chrysomyia bezziana.
Stomoxys calcitrans.
Glossinæ (various).

Beetles:

Dermestes lardarius } affect cured meat (bacon and
Dermestes volpinus } hams).

Lice:

Hæmatopinus suis.

Ticks:

Boophilus decoloratus (*Piroplasma trautmanni*).

Mange mites:

Sarcoptes scabiei (var. *suis*).
Demodex phylloides (*D. folliculorum*) (var. *suis.*)

WORMS

Trematodes:

Fasciola hepatica.
Fasciolopsis buski.
Dicrocœlium dentriticum (*Distomum lanceolatum*).
Opistorchis felinus.
Clonorchis sinensis.
Echinochasmus perfoliatus.
Metagonimus yokogawai.
Paragonimus westermani.
Paragonimus kellicotti.
Gastrodiscus ægyptiacus.
Schistosoma japonicum.

Cestodes:

Cysticercus cellulosæ (*Tænia solium*).
Cysticercus tenuicollis (*T. hydatigena* or *marginata*).
Echinococcus granulosus (*E. veterinorum*).

Nematodes:

Ascaris lumbricoides (*A. suis*).

Strongyloides westeri.
Strongyloides ransomi.
Trichinella spiralis.
Trichuris trichiura (T. suis, T. apri or *T. dispar).*
Bourgelatia diducta.
Œsophagostomum dentatum.
Stephanurus dentatus.
Ancylostoma duodenale.
Necator americanus (N. suillus).
Globocephalus (various).
Trichostrongylus instabilis.
Hyostrongylus rubidus.
Mecistocirrus digitatus.
Ollulanus tricuspis.
Metastrongylus apri.
Metastrongylus pudendotectus.
Metastrongylus salmi.
Ascarops strongylina.
Ascarops dentata.
Physocephalus sexalatus.
Simondsia paradoxa.
Gongylonema pulchrum (G. scutatum).
Gnathostoma hispidum.
Setaria bernardi.

Acanthocephala:
Macracanthorhynchus hirudinaceus (Echinorhynchus gigas).

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Chapter 15

POISONS AND POISONOUS PLANTS

POISONING may be acute, subacute or chronic, depending upon the amount consumed. Poisonous substances may be organic or inorganic, and pigs may be poisoned through the food or through the administration of poisonous substances in the form of drugs which in sublethal doses may even have a beneficial effect on the body. The degree of poisoning will depend upon the rate of absorption, its distribution and accumulation in the tissues, and its elimination from the body. Idiosyncrasy, the species of animal and age of animal affected also affect the actions of some substances. Certain poisonous plants are more likely to be eaten in the spring and summer months, and are more poisonous in the young stages; others possess less poisonous properties when young and tender than when fully grown. Owing to the methods adopted for rearing and fattening pigs, poisoning is not so likely to occur in them as it is in some other farm animals.

When sudden deaths occur and there is reason to suspect poisoning, a careful post-mortem examination should be made and full notes taken of all findings. The lesions are never very characteristic, and generally consist of some evidence of acute gastro-enteritis. A chemical analysis should be undertaken, and for this purpose the stomach and intestines should be carefully tied up with the contents intact in the case of the smaller pigs. This is especially important in cases of suspected poisoning with vegetable matter. In larger animals the stomach and intestinal contents should be placed in a sealed receptacle and forwarded with a full account of the case for analysis. Portions of liver, kidney, some blood and, if possible, urine should also be included, and no preservative should be used. Where poisoning is suspected in small pigs, and numbers are dying, it may be best to send a complete dead pig unopened.

According to the late Professor Lander, the results of a

chemical analysis are in the majority of cases of value only as confirmatory evidence, as the mere discovery of the presence of a poisonous substance does not necessarily mean that damage has been caused, and a chemical analysis is thus not diagnostic but corroborative.

Mineral Poisons

Arsenic.—Arsenic is found in many substances, but the most poisonous compounds are the hydride and some organic compounds. Arsenious oxide, arsenious acid and its salts are the commonest forms of arsenic. Arsenic may be found in some rat powders and sheep dips, condition powders for horses, and it may contaminate water and pasture in the neighbourhood of metal smelting works and in mining districts. The toxic dose will depend upon the nature of the arsenical compound, and, according to Kaufmann, the approximate poisonous dose of arsenious oxide in powder form given *per os* is 7·5 to 15 grains for the pig, or 0·3 grain powder absorbed from a wound.

Symptoms.—The symptoms of acute arsenical poisoning are very rapid in onset. There is a loss of appetite, thirst, vomiting, salivation, colic with diarrhœa, sometimes bloody, and there may be paralysis of the hindquarters, great debility, and a subnormal temperature, followed by death. In the more chronic form there may be some giddiness, indigestion, thirst, great weakness, some joint swellings, albuminuria and hæmaturia. Death may occur from asphyxia due to lymph exudation.

Post mortem.—There is a gastro-enteritis with intense inflammation of the mucous membrane, a fatty degeneration of the liver, kidneys, heart, and even of the nervous centres in some cases. In other cases there may be very little inflammation. There may be some lymph exudation from the mucous membrane of the mouth and fauces, larynx and trachea, producing asphyxia.

Treatment.—Precipitated iron oxide and calcined magnesia are specific antidotes. Lime water, milk, egg white should be given with a purgative. Access to the poison should be prevented.

Arsanilic Acid used as a food additive to promote growth in

pigs (at 25 to 45 p.p.m.), can set up poisonous symptoms in the central nervous system leading to blindness and inco-ordination of movement. Temperature and consciousness are not affected.

Antimony.—Antimony preparations have been used as vermicides and as ingredients of condition powders in horses, and cases of poisoning by antimony in pigs have also been recorded, the symptoms being gastro-enteritis and vomiting, with some acute abdominal pain. Post-mortem lesions consist of an inflammation of the mucous membrane of the stomach and small intestine, a fatty degeneration of the liver, with impaction of the stomach.

Tannic acid is used as a chemical antidote to antimony, and treatment follows that prescribed for arsenical poisoning.

Lead.—The common preparations of lead likely to give rise to cases of poisoning in pigs are the basic carbonate of lead, white lead, used in paint manufacture and in the making of oilcloth and linoleum. Nowadays substitutes are used for the lead preparation in linoleum manufacture. Land and pasture may also be contaminated by the effluvia from lead works, and lead from the refuse of old disused workings has been known to contaminate streams and pasture-land. The ingestion of lead bullet splashes and drinking of water containing lead are also said to cause chronic lead poisoning, or plumbism.

Bywater reported some lead poisoning in a herd of pigs fed on weatings, bran and swill from a mental hospital. The pigs were disinclined to feed, fæces passed became blood-stained, black in colour and rather firm, whilst in the dead animals a post-mortem examination revealed an acute gastritis only. The live pigs showed some discoloration of the skin in patches over the abdomen and around the ears, the discoloration being a dull purple-blue, and when viewed in the shadow of the sty the discoloured skin gave the impression of having been rubbed with an ordinary lead pencil. The patches were sharply defined and only the skin was discoloured, the hair being the normal white colour. Some inco-ordination of movement was also shown by these pigs, especially in the hind-limbs. Some were only able to drag themselves about with difficulty on the fore-limbs, and this stage was followed by prostration and death. Organs were sent for analysis to

Professor Clough of the Royal Veterinary College Hospital, and lead was found to be present in the viscera, the amount being approximately ½ grain from an ounce of ingesta and organs, death being attributed to acute or subacute lead poisoning. The source of the poison was believed to be some soluble lead salt (acetate of lead ?) having inadvertently got into the swill, possibly from the hospital stores or dispensary. Only one dose is believed to have caused the trouble, and pigs were dying up to sixty days afterwards.

Lead is slowly absorbed by the body tissues and is retained in the organs for a long time.

Symptoms of Lead Poisoning.—These may be slow in developing and may take two or three days before the first symptom appears. The animal may refuse any food and show signs of gastro-enteritis, with the passing of greyish-white fæces, salivation, convulsions and violent frenzy, blindness, and death. These symptoms may be slowly progressive for about a fortnight before there is a fatal termination. The blue line on the gums alleged to be caused by the deposition of lead sulphide is not seen in animals affected with lead poisoning.

Treatment.—The advent of the sequestrating agent, calcium disodium ethylenediamine tetracetate, known under its proprietary name of Calcium Versenate, has greatly facilitated the treatment of lead poisoning in all species of animals.[1] The drug is given by slow intravenous injection if possible, but the subcutaneous route may be used with less rapid effect. The calcium versenate combines with lead (and possibly other heavy metals) to form a soluble but non-ionizable and therefore non-toxic complex which is rapidly excreted. Deposited lead is leached from bones and organs. It is, however, very important to precipitate alimentary lead with oral administration of soluble sulphates, casein, milk or white of egg to ensure that further toxic absorption does not take place.

Convulsive symptoms can be controlled with chlorpromazine, but these will in any case disappear with the excretion of lead.

Mercury.—Mercury preparations are often used medicinally in pigs. The mercurous chloride (calomel) is sometimes employed as a purgative. It is generally non-toxic except when

[1] Penicillamine may prove to be an even more effective chelating substance than Calcium Versenate.

very large doses are given. The bichloride is a powerful corrosive (corrosive sublimate), and the biniodide is also used in blistering and other ointments. Mercurial salts are rapidly absorbed and may pass into the circulation in the form of albuminates, being stored mainly in the liver and kidneys. *Elimination from the body is slow and is via the kidneys* and intestines chiefly. Calomel is usually converted in the intestines into the black sulphide, and very little of it is absorbed.

Symptoms.—There is some salivation, with anæmia of the buccal mucous membrane and loosening of the teeth. There may be some soreness of the mouth, with diarrhœa or even dysentery, and emaciation followed by death. In chronic cases symptoms may not be very pronounced for some months.

Post mortem.—Mucous membranes may be inflamed and those of the stomach and intestine may even be perforated or ulcerated. There may be an acute peritonitis, a nephritis, and a diphtheritic inflammation may be seen in the large intestine, whilst the spleen may also be the seat of an inflammation.

Treatment.—The administration of egg white by mouth precipitates the albuminate. Sulphur also acts by forming an insoluble sulphide. Potassium chlorate and potassium iodide are also useful and help elimination of the metal from the body.

Copper.—Copper sulphate, or blue vitriol, is the salt commonly used medicinally or added to pig food, whilst copper arsenite or Scheele's green may sometimes be used in paint. Orchard sprays also contain copper.

Copper is absorbed fairly quickly and is deposited in the liver, kidneys and lungs, elimination by the bile and urine being very slow. Concentrated solutions are said to act as irritants, whilst dilute solutions have an astringent and antiseptic effect, causing capillary contraction and a drying up of secretions. In testing livers from dead pigs Gordon and Luke found from 2,450 to 2,160 parts per million in two. Meal mixers add copper sulphate to pig meal at the rate of ½ to 1 lb. per ton as part of mineral supplements to control scouring and to improve growth. (This is equal to from 50 to 100 p.p.m. of copper.) There is a variation in the copper content of livers from 35 to 264, 54 to 159, and 38 to 170. In fœtal livers there is a mean value of 121 p.p.m., in baconers 99 p.p.m., and in sows 103 p.p.m. *In adult pigs* 40 p.p.m. is regarded as normal

A uniform and complete mixing of the copper sulphate in the pig meal is not always easy.

Symptoms.—At first temperature remains normal and the appetite is maintained, but this is lost as the condition progresses. Pigs become unsteady in their gait. Urine, which is passed in small quantities, is often blood coloured. Frequent attempts are made to urinate but little is passed. Later the animals become very constipated and the temperature rises to 106°F. The skin becomes yellow, there are muscular spasms, colic, and even paralysis of the hindquarters. This is followed by collapse and death.

Post mortem.—This reveals a generalized icterus.

Treatment.—Egg albumin, milk, potassium ferricyanide, grape sugar or milk sugar, sulphur, iron, and animal charcoal may be used, with mucilaginous drinks.

Zinc.—Poisoning from zinc salts is very rare. Zinc oxide and zinc carbonate are used in paints, and zinc sulphate is often used medicinally, as is zinc acetate. The soluble salts of zinc are absorbed by the body and may be found in the liver, kidney and spleen. Elimination from the liver is slow.

Symptoms.—There is a loss of appetite, frothing at the mouth, vomiting, dullness and general wasting, with diarrhœa.

Post mortem.—The lesions found include some congestion of the lungs, gastro-enteritis, with very watery fæces.

Treatment.—Antidotes consist of alkaline carbonates, which render the zinc salt insoluble. Emetics may be given to help rid the drug from the stomach, and demulcents to ease the gastro-enteritis.

Silver.—Silver poisoning is not important as far as pigs are concerned. The common soluble nitrate is used as a caustic. The chloride and bromide are used in photography, as is the cyanide, which is a dangerous poison. Protargol is a non-irritant silver preparation. Small and repeated doses of silver cause a condition of argyria, when the skin is blackened. The symptoms are those of acute gastro-enteritis, vomiting, paralysis, convulsions and death. In argyrism there is some anæmia, indigestion, and general debility with emaciation. Sodium chloride is the chemical antidote, forming a silver chloride. The salt should be diluted and not given in large

doses. Other measures are similar to those recommended in dealing with mineral poisons generally.

Barium.—Barium is used in some rat powders, in the glass industry, and medicinally. The salts are not easily absorbed from the intestinal tract, and they act as irritants and purgatives, and in toxic doses slow the heart beat, causing convulsions and death. Sodium or magnesium sulphates are the antidotes, forming an insoluble barium sulphate.

Chromium.—Some chromium salts are used in making paints, and in chrome tanning for leather. Chrome poisoning causes convulsions, a lowering of the temperature, lack of consciousness, and death.

Phosphorus.—Phosphorus forms part of some rat-killing preparations, and Lander gives 2·5 to 5 grains as a toxic dose for a pig. Phosphorus acts as an irritant to the mucous membrane of the bowel, and is slowly absorbed, so that symptoms are delayed. Toxic doses cause some vomiting, a thirst, a high temperature, some abdominal pain, jaundice, convulsions, coma and death, which may take place after several days' illness. The breath, fæces and urine may be luminous in the dark.

The post-mortem lesions are those of gastro-enteritis, with a fatty degeneration of the liver, heart, and some muscles of the body.

Treatment consists in administering an emetic such as copper sulphate, which is also believed to act as an antidote. Oily purgatives must be avoided, as they promote absorption

Selenium.—The toxicity of sodium selenite is countered by arsenilic acid (0·01 per cent.) against 13 p.p.m. of the selenite. Organic arsenicals give best protection when fed with linseed oil meal. It is possible that the protective action of the mucin content may help.

Acids and Alkalis.—These exert their effect when in concentrated form, owing to their chemical action upon living tissue. They attract water and thus act as dehydrants, the acids coagulating protein and the alkalis decomposing fats and proteins. Living tissue is destroyed, and a local lesion is left. Vomiting, colicky pains, diarrhœa, and exhaustion followed by death, are the symptoms usually observed in

poisoning from these causes. Caustic soda may cause perforation of the lining of the stomach and bowel.

Treatment.—Acid poisoning is treated by dilute alkalis such as chalk, burnt magnesia, a weak soda or soap solution. Alkali poisoning is counteracted by very weak acid solutions such as vinegar, followed by oils.

Salt Poisoning.—This is of importance in the pig, as salt is a likely ingredient of swill, and many cases of swill poisoning are undoubtedly due to some of the sodium chloride, sulphate, potash, etc., which may be contained in the swill. Brine has also been blamed for poisoning pigs, but it is believed that the trouble in such cases has been due to the bacteria contained in the brine rather than to the salt. Some doubt also exists as to the toxic dose for pigs; some say that from 2 to 8 oz. of salt will produce poisonous symptoms in pigs, other authorities give from 4 to 8 oz. as a poisonous dose. Professor Wooldridge gave a pig six consecutive 3-oz. doses of salt without observing any ill-effects. Professor Lander quotes a similar instance of large doses of salt having no ill-effects on the pig, and doubts the possibility of many of the so-called salt poisoning cases being due to sodium chloride poisoning, as brines may contain organic poisons derived from the decomposition of proteins.

The control of water intake by pigs and the addition of sodium chloride to the ration does produce salt poisoning as has been shown by some American experiments. Symptoms are produced by as little as 2·5 per cent. sodium chloride in swill when water intake is restricted. Sodium propionate fed in a 4 per cent. concentration also sets up clinical symptoms of poisoning. Microscopic changes take place in the cerebral cortex, such as œdema and eosinophilic meningo-encephalitis.

Brine poisoning is known in pigs. Buffagni describes poisoning in pigs after having had large quantities of brine in their food. He gives the toxic dose of common salt for the pig as 1 g. per kg. of the body weight. Fröhner gives from 125 to 250 g. of common salt as being fatal to pigs, and it is known that fish meal containing as much as 15 to 17·5 per cent. of sodium chloride causes deleterious effects on pigs. Slight fever and lesions in the central nervous system can be set up by the administration of salt to pigs. Blindness and

obstinate constipation were set up in pigs having had 400 g. of brine (60 to 80 g. sodium chloride) each for eight days. There seems no doubt that pigs are fairly susceptible to salt poisoning.

Concentrated solutions of salt, when in the alimentary canal, cause an increased flow of water from the tissues, setting up some irritation and vomiting.

Symptoms.—There is a lack of appetite, thirst, champing of the jaws and salivation. Diarrhœa may or may not be present. The pigs sit on the hindquarters, then roll over on to their sides. The pupils dilate, sight is lost, convulsions and paralysis of the hindquarters set in. The symptoms are rapid in onset, and death takes place within three days.

Post mortem.—There is an acute gastro-enteritis, with hyperæmia in the meninges. The blood coagulates rapidly.

Treatment.—Fresh clean water should be allowed to the animals affected, and the animals given some demulcents, the offending food or suspected substance being removed.

Meningo-encephalitis of swine.—This affects pigs just after weaning, and may lead to convulsions and death within 24 hours. Store pigs have also developed the condition after being fed with a proprietary pig meal containing 7·2 per cent. of common salt. Withholding the food concerned stops the disease from spreading in the herd. Experimentally, the feeding of pigs on diets containing from 5 to 9 per cent. of common salt, without any water, has set up the condition. Rac, Bray and Lynch also reported a meningo-encephalitis eosinophilica in pigs due to eating salt-contaminated whey. Here serum examinations showed it was the sodium concentration alone that increased.

Symptoms.—Affected animals stand still with a strained expression, this being followed by champing of the jaws, frothing at the mouth, violent muscular tremors, backward movements and collapse. This kind of fit recurs often, and in between bouts the pig wanders blindly round the pen.

Post mortem.—There are no significant naked-eye changes, but histologically the brain shows a non-suppurative encephalitis with perivascular cuffing and some degeneration of neurones. This is most severe in the front part of the cerebrum. Vascular cuffs consist of about 90 per cent. eosinophil leucocytes with

some round cells, but no inclusions or bacteria. Neutralization tests show the disease fails to neutralize egg-adapted strains of the Aujesky's disease virus.

Sodium and Potassium.—Some of these substances may be used in brine, and sodium nitrate is also used as a manure. They may be present in pig swill, and give rise to symptoms similar to those for salt poisoning, and the treatment is also similar. It is possible that many cases of salt poisoning are due to sodium or potassium nitrate rather than to sodium chloride.

Potassium nitrate is toxic for pigs when given in over 30 g. doses. The therapeutic dose is from 1 to 4 g. Poisonous doses produce nausea, vomiting, diarrhœa, and a suppression of the urine.

Sodium fluoride, which is used as a worm remedy for pigs, can set up symptoms of poisoning, if the drug is given in excessive doses. The symptoms resemble those described here, with great weakness, muscular tremors, and death. As is the case with many poisonings, lesions of gastro-enteritis are found on post-mortem examination, with congestion of the kidneys and liver.

Sulphur.—Sulphur is often used medicinally, and in large doses is apt to cause poisonous symptoms. The gastric juices do not act upon free sulphur, but it is converted into a soluble sulphide in the intestine and is further reduced to sulphuretted hydrogen, which is intensely poisonous.

Symptoms.—These come on fairly rapidly and consist of vomition, diarrhœa and dysentery, coma and death.

The post-mortem lesions found are those of an acute gastro-enteritis, the blood is dark in colour and does not easily clot, and sulphur particles are found in the stomach and intestines, as well as the fæces. The body tissues smell of sulphuretted hydrogen.

Treatment.—This consists in giving eggs in milk, castor oil, bismuth subnitrate, flour gruel, rice-water enemata.

Chlorine, Bromine, Iodine.—Poisoning by these substances or their compounds is very rare, and only occurs when very large doses are given. Chlorine and bromine in the form of concentrated vapour are dangerous, attacking the respiratory system primarily, causing coughing and the discharge of

bloody mucus, coma and death. Iodism occurs following repeated administration of large doses of iodine, and is marked by nasal catarrh, pharyngitis and catarrh of the alimentary tract, a general weakness and emaciation.

In treating these conditions boiled starch has been recommended for fixing free iodine, whilst small quantities of sulphuretted hydrogen or ammonia act as chemical antidotes against chlorine and bromine. Alcohol or ether vapour is said to be preferable, owing to the toxic nature of the sulphuretted hydrogen and ammonia.

Carbon Monoxide.—Carbonic oxide is formed in the incomplete combustion of carbon, and is contained in producer gas, coal gas, and water gas, and is a constituent of choke damp. It is rapidly absorbed by the pulmonary mucosa and passes into the blood stream in the form of carboxyhæmoglobin. The stability of this latter product prevents oxygenation of the blood, and an atmosphere containing over 3 per cent. is highly poisonous.

Treatment consists in the administration of oxygen, or electrical treatment with one electrode (positive) in the rectum and the other (negative) in the mouth.

Coal Tar Pitch Poisoning.—Coal tar (Pix carbonis) is obtained by the destructive distillation of bituminous coal. Its chief constituents are benzene (C_6H_6), phenols, cresols, naphthalene, anthracene, aniline, pyridine, acridine, carbazole, thiophene, etc. Cases of poisoning in pigs by coal tar pitch have been described by three American veterinarians. Four separate outbreaks have been recorded in which bacteriological examination failed to reveal any cause, whilst the possibility of plant or fodder poison was also eliminated. It was established that in two out of the four outbreaks recorded the pigs had access to the remains of clay pigeons used by gun clubs. These clay pigeons were found to be composed of coal tar pitch and a protective layer of calcimine. Group feeding experiments were carried out, using the remains of clay pigeons, commercial coal tar pitch, and lead shot. Copper was excluded as a possible exciting factor, and lead shot failed to produce any liver lesions. Pigs fed on a diet containing powdered clay pigeons and commercial coal tar pitch showed identical symptoms and lesions exhibited by the naturally

affected pigs. Luke describes a case where old railway sleepers had been used as flooring in pig pens. These sleepers were levelled off with pitch, which was eaten by some unthrifty pigs.

Symptoms.—These are characterized by inappetence, dullness with the usual signs of general unthriftiness and pain, a rough coat, tucked up abdomen and great weakness. Death may take place in a few hours. The condition seems to affect young pigs between the ages of six to twenty weeks, and has little effect upon adult pigs.

Post mortem.—The most characteristic lesion is in the liver, in the form of a central necrosis of the hepatic lobules, giving the organ a red or mottled appearance, which affects the whole liver in severe cases. Other lesions are jaundice of the subcutaneous tissues, œdema and a marginal congestion of the lymph nodes, with a straw-coloured liquid in the abdominal cavity.

Treatment.—The observers who described the American outbreaks do not mention any specific line of treatment. Coal tar products have long been known to produce poisonous effects when animals are given an overdose. Sulphates of magnesium or of sodium are the recognized suitable antidotes to the creosote poisonings. (See Carbolic Acid.) Olive oil and lime water may be given orally, and stimulants to ward off collapse. Other antidotes which may be used are saccharate of lime, vinegar, camphorated oil. Sulphate of sodium may be hypodermically injected, but magnesium sulphate solutions should be given *per os*, owing to possible toxic action if injected under the skin.

Organic Poisons

Hydrocyanic Acid.—Prussic acid is one of the most powerful poisons, and it may be generated from certain plants under special conditions. It occurs in the vegetable kingdom in combination in the form of a cyanogenetic glucoside. The glucoside, when hydrolysed by dilute acids or by the action of enzymes, is decomposed and yields sugars and other products, including hydrocyanic acid. The cherry laurel is a plant containing amygdalin, the glucoside of the bitter almond. Others are the Java or Rangoon bean, a species of vetch, millet, maize, common flax, and the mutter pea. Linseed cake

is only poisonous under exceptional conditions, as it yields but a small percentage of hydrocyanic acid. Poisoning only occurs after the pulped mass has been masticated at body temperature, when conditions are favourable for fermentation.

Hydrocyanic acid and its soluble salts are absorbed through the skin, and the vapour is rapidly absorbed via the lungs. Respiration is at first accelerated and then speedily inhibited. Elimination takes place through the lungs, the exhaled air having a characteristic faint almond-like odour.

Symptoms.—Large doses act very rapidly, producing an arrest of the heart beat in diastole, with paralysis. When the poison is given by the mouth it causes salivation, vomition, convulsions, spasms, vertigo, paralysis, cessation of respirations and heart beat.

Post mortem.—Animals dead from hydrocyanic acid poisoning show gastro-enteritis, hyperæmia of the central nervous system, inflammation of the heart muscle, congestion of the lungs, and the blood is black and oily, whilst gas bubbles are found in the heart cavities, and a smell of bitter almonds is given off by the body tissues.

Treatment.—Freshly precipitated ferrous hydrate made by mixing iron sulphate and solution of potassium is an antidote. Ether and chloroform vapours, ammonia, atropine, the injection of sodium sulphide and sodium thiosulphate may be used also, and emetics or the use of the stomach pump to clear out the stomach contents. As a rule the condition is so rapidly fatal that treatment cannot be resorted to. Where pigs have been fed on a ration containing some cheap bargain such as Chilean peas, or foods containing Java beans or mutter pea, numbers of the animals may be found dead, having exhibited little symptoms of illness. The offending food should be destroyed, and not fed to any other animals.

Carbolic Acid.—Phenol compounds are largely used as disinfectants, and crude creosote is used for impregnating wood fences and timber. Coke-oven and gas-works effluents may also contaminate water. The poisonous properties of phenol will depend largely upon the channel of absorption and the dilution of the chemical.

Symptoms.—The concentrated carbolic acid is a violent corrosive which precipitates albumins, and is more penetrating than any corrosive. Shock and collapse may follow large doses. Dilute doses cause tetanic convulsions, chorea, paralysis and death.

Post mortem.—Intense gastro-enteritis with pallor of the pharynx and œsophagus, and a distinct smell of carbolic acid in the viscera.

Treatment.—Sodium sulphate is used as an antidote, so as to facilitate the formation of sulpho-carbolates in the urine, as carbolic acid is eliminated in the form of sulphuric acid derivatives. Lime sucrate and intravenous injections of ammonia have also been used. Other agents are zinc sulphate, egg albumin, milk, chlorodyne and lime water. Strong purgatives and whisky and oil of turpentine have also given good results.

Strychnine.—The alkaloid strychnine is found with others in the seeds of the *Strychnos nux vomica* in the Far East and in various seeds of Loganiaceæ in the East. The drug is used medicinally, and vermin powders often contain strychnine. Strychnine is slowly absorbed through the intact skin, but rapidly through mucous membranes, and is quickly transported via the blood to the central nervous system and organs. It is not rapidly eliminated; after passing into the saliva and urine, elimination may not be complete for about three days. The drug thus exercises a cumulative effect. The toxic dose for the pig, according to Kaufmann, is 0·15 to 0·75 grain of strychnine, and from 60 to 90 grains of nux vomica.

Symptoms.—Stimulation of the motor cells of the spinal cord, resulting in tetanic spasms, during which the back may be curved (opisthotonos), with tense muscles and great rigidity of the limbs. There may be some vomiting and a slight rise in temperature. Respirations may be arrested and death may result from asphyxiation.

Treatment.—Emetics to remove the poison.

General anæsthesia under barbiturates may be needed. This should be supported by sedation with chloral hydrate or chlorpromazine until the strychnine has been eliminated.

Santonin.—Santonin is the active principle of the flower heads of the shrub Santonica (*Artemisia maritima*), and is used

as a vermicide in pigs. Symptoms of poisoning may occur when an overdose is given, and may sometimes prove fatal. It causes epileptiform convulsions and clonic spasms, when the respirations may be interfered with and death may occur. It gives a blood-red colour to the urine and may also cause a temporary blindness.

Treatment is by emetics and purgatives, the convulsive symptoms being prevented by chloroform, chloral or bromide.

Sulphaguanidine.—In certain experiments with this drug in the treatment of infectious enteritis in pigs Kernkamp and Roepke report toxic symptoms following the administration of a dose exceeding 2 grammes per 10 lb. body weight per day. These symptoms they describe as inappetence, followed by locomotor inco-ordination, characterised by a stiff upward and forward stride of the hind-legs, with general weakness, leading to death. A post-mortem examination revealed signs of nephrosis.

Sulphaguanidine is apparently not readily absorbed, but a considerable proportion is excreted via the kidneys.

Warfarin.—Although the rat poison "Warfarin" is said to be non-poisonous to domestic animals, cases of deaths in pigs due to eating meal containing this rodenticide are known. It usually happens when young pigs accidentally obtain access to some food containing Warfarin. This substance (3(alpha-acetonyl benzyl)-4-oxycoumarin) is obtained from dicoumarin, the active ingredient said to be responsible for sweet clover disease in cattle. The effect of Warfarin on the animal body is to cause capillary damage. The formation of prothrombin is prevented, and hæmorrhage is often the cause of death. It is therefore particularly necessary to prevent the little pigs from obtaining any meal dosed with rodenticide at castration time.

According to Miss Susan T. Clark, B.Sc., M.R.C.V.S., of the Royal (Dick) School of Veterinary Studies, Edinburgh University, several small daily doses of Warfarin have been shown to be more effective on rats than doses on alternate days for a short period. She quotes an optimum dose for rats of 5 mg. per kg. body-weight over a period of five consecutive days, so as to cause death in from 2 to 12 days. A single dose of 15 to 500 mg. per kg. body-weight has only slight effects, killing only

10 out of 240 rats. Miss Clark found the deaths of 5 piglets in a litter of 11 to follow on the consumption of $1\frac{1}{2}$ lb. of meal containing 0·025 per cent. of Warfarin—a total of 180 mg. of the poison. Each piglet could have eaten an average amount of about 30 mg. of pure Warfarin over a period of several hours. In other cases quoted, the little pigs had access to the baited

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FIG. 95.—WARFARIN POISONING. ABDOMINAL HÆMORRHAGE.
The intestines are deflected to show extensive hæmorrhagic area on right abdominal wall.

meal for about twelve days before castration. The work of Stableforth at the Veterinary Laboratory of the Ministry of Agriculture and Fisheries shows that single doses of up to 3 mg. per kg. body-weight fails to produce any effects, but doses of 0·4 mg. per kg. body-weight if given daily for seven days will produce symptoms of Warfarin poisoning, and in some cases, death. Miss Clark is of the opinion that even small amounts

of Warfarin taken as a single dose over a period of a few hours can have a toxic effect within three to six days.

Greer reports how three store pigs of 100 lb. live-weight each were fed in error a bucketful of Warfarin poisoned meal. The mistake was discovered an hour later, and two hours after that each pig was given 20 mg. of vitamin K analogue. No symptoms appeared, and when these pigs were mixed with others, and

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FIG. 96.—WARFARIN POISONING.

The neck of a young pig dissected to show hæmorrhagic area.

fighting took place, this did not provoke any hæmorrhages in the Warfarin fed pigs.

Symptoms.—Swellings appear on various parts of the body due to subcutaneous hæmorrhage and hæmatomata. Recently castrated pigs bleed from the severed spermatic vessels, and any bumps or bruises result in hæmorrhage. If the skin is intact and the intake of Warfarin is not too great, some pigs may recover in a few days. (In rats the poison is said to have

effects on the heart muscle.) Warfarin also affects the liver and other tissues. Death in the affected piglets usually occurs from hæmorrhage and the resulting anæmia.

Post mortem.—The carcase and organs appear very pale and anæmic, with some free blood in the body cavities as well as subcutaneously. Hæmatoma and hæmorrhages are found on various parts of the body, the limbs, and the intestinal walls

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FIG. 97.—WARFARIN POISONING.
The skin dissected from the hind-legs of a pig showing extensive hæmorrhage in the left hind-leg.

may also show patchy hæmorrhages, whilst the stomach is full of recently consumed meal.

Treatment.—Access to Warfarin-doped meals should be prevented at once. Piglets known to have consumed the suspected meal should be kept warm and quiet, with as little handling as possible owing to the possibility of bruising so easily. A laxative meal may help the pigs to recover. The

coagulation of the blood can be restored by the intravenous injection of defibrinated blood from normal pigs, or by citrated blood (3 per cent. sodium citrate per litre), and even serum may be useful. Dried pig serum fed powdered in small quantities in a meal is worth trying, but unfortunately these treatments are hardly warranted unless the pigs are very valuable, and the commercial production of dried pig blood-serum is not even in its infancy yet.

Chlorinated Hydrocarbon Insecticides.—A number of these preparations which are prepared by chlorination of various *hydrocarbon compounds* are in wide use as long-acting insecticides. The group includes the substances known as DDT, BHC, Aldrin and Dieldrin.

DDT (*Dichlore-diphenyl-trichloroethane*).—This is a white crystalline solid, insoluble in water but soluble in various organic compounds and fats. Commercial preparations containing DDT are well known and are used for controlling ectoparasites of plants and animals. Toxic amounts of DDT cause death by excitation of the central nervous system, followed by depression and respiratory failure. Ventricular fibrillation as a cause of death from DDT poisoning is usually found in dogs. Chronic poisoning causes liver damage. The pig appears to be somewhat resistant to the toxic effects of DDT. They have been fed with doses of 0·5 g per kg. without ill effect and have been sprayed with 5 per cent DDT solutions without harm. Nevertheless, the possibility of symptoms of poisoning following repeated use of DDT preparations, particularly on young pigs, must be kept in mind.

BHC (*Benzene Hexachloride*).—This is a waxy solid, light-brown to white in colour, with a musty odour, insoluble in water but soluble in fats and organic substances. Commercial preparations containing BHC are on the market, usually as 5 per cent powders for lice control in pigs and other animals. BHC is believed to be less toxic than DDT The toxic symptoms are dullness, inco-ordination of movement, convulsions and death. Repeated spraying of pigs with a 1 5 per cent. solution has not proved harmful.

Aldrin and Dieldrin.—These are chlorinated naphthalene derivatives The former is a whitish solid with a pine-oil odour and is one of the most toxic of this group for domesticated

animals, though pigs appear to be relatively resistant. **Dieldrin** is chemically similar to **Aldrin,** being a white odourless solid. The toxic dose of young pigs according to Garner (1957) is 25 to 50 mg. per kg. body weight. Both substances can be absorbed through the intact skin to produce symptoms similar to DDT and BHC.

Treatment in cases of poisoning by this group should aim at controlling convulsions by means of drugs depressing the central nervous system and keeping the animals in a quiet place. The source of intoxication should be removed and, if necessary, the skin of the patient cleansed. Calcium borogluconate injections are of value in neutralizing the effects of serum potassium rise. Saline purgatives should also be administered.

Organophosphorus Insecticides.—This group includes numerous compounds consisting of derivatives of phosphoric and thiophosphoric acids, which are as toxic as the chlorinated hydrocarbons. Their action is due to their ability to inhibit cholinesterase, an enzyme which hydrolyses acetylcholine. They are readily absorbed by all routes, some having a direct and rapid inhibitory effect while others are converted, after absorption, into inhibitory compounds producing delayed effects.

Symptoms are due to excess retention of acetylcholine with over-activity of parasympathetic nerves. Salivation, vomiting, abdominal pain and diarrhœa are seen. Muscular twitchings may also be noticed as well as lung embarrassment which leads to death from respiratory failure.

Treatment.—As a specific antidote, atropine will be of benefit in controlling the abdominal and respiratory symptoms. The source must be removed and animals decontaminated.

Dinitro-compounds (Weedkillers).—These herbicides, which include 2,4-dinitrophenol (DNP), 2,4-dinitro-orthocresol (DNC or DNOC) and 2-sec-butyl-4,6-dinitrophenol (DNBP), are widely used as agricultural and horticultural sprays. Absorption in animals can take place through most routes, including the intact skin, and the toxic agent may be cumulative in action because of the slow rate of detoxication. McGirr and Papworth (1953) state that the single, oral, lethal dose for the pig is between 50 and 100 mg. per kg.

Symptoms.—These substances act as a stimulant to metabolism which soon leads to listlessness, loss of appetite and

activity, rapid respiration, sweating, thirst, prostration and death. The temperature is raised, especially in the terminal stages.

Treatment.—There is no specific antidote and treatment must be largely symptomatic. The animal must be kept as cool as possible. Sedatives may be given to keep them quiet and gluco-saline injected to combat dehydration.

Stilbœstrol Poisoning in pigs has been reported upon by Taylor and Gordon. Pigs fed with stilbœstrol B.P. 13·4 grammes per ton of food, plus thyrozine 0·672 g. per ton (*i.e.* 6 mg. per lb. and 0·3 mg. per lb.), showed poisoning symptoms in the second week of the experiment.

Symptoms.—These appear suddenly, and consist of persistent straining, anorexia, difficult respiration but with normal temperature. Rectal eversion with necrosis, inco-ordination of hind limbs, the legs being abducted, and there is also evidence of pain on palpation of the hypogastric region. Later pigs show incontinence and anuria followed by collapse and death.

Post mortem.—Carcases are poor in appearance, with bloody exudate in the thorax, a clear straw-coloured fluid in the abdominal cavity, and œdema of the retroperitoneal tissues. Heart is hypertrophied and weigbt increased up to 64 per cent. plus epicardial hæmorrhages and blood-congestion of the mesentery. Kidneys enlarged to about 24 per cent. congested and having petechial hæmorrhages in the cortex. Uterus thick and bladder very distended. The pelvic urethra enlarged and thickened in the mucosa. Prostate gland and seminal vesicles grossly enlarged. The thyroid glands were 30 per cent. lighter in the stilbœstrol and thyroxine-fed pigs than in the controls.

The obvious treatment is to withhold such substances from the pig ration.

Poisonous Plants

Yew.—The leaves of the yew tree (*Taxus baccata*) and its varieties contain an active principle, taxine. This alkaloid is only found in small quantities in the berries. Taxine acts as a narcotic, producing paralysis of the respiratory centre and death by suffocation. The toxic dose for the pig, according to Cornevin, is 22 grains per lb. body weight.

darnel in pigs are foaming at the mouth, convulsions and paralysis. There is acute gastro-enteritis and congestion of the lungs noticeable at a post-mortem examination.

Maize.—The male flowers are said to be dangerous, resulting in urinary troubles. Young maize is said to be capable of generating hydrocyanic acid. Mouldy maize has been accused of causing vulvovaginitis in pigs.

Millet.—This contains a cyanogenetic glucoside, durrin, from which hydrocyanic acid is formed by the action of enzymes.

Trefoil (*Medicago denticulata*) and *lucerne* (*Medicago sativa*) have been blamed for causing a dermatitis in white pigs, the dermatitis appearing behind the pig's ears and along the back. The condition is said to clear up when the pigs are removed to pastures where there are no legumes.

Aconitum.—*Aconitum napellus*, monk's hood or wolf's bane, is dangerous owing to the alkaloid aconitine it contains. It is present in the root in a larger proportion than in the leaves and stem, etc. It is rapidly absorbed by the body and slowly eliminated by the kidneys. It causes salivation, champing of the jaws, vomition and purgation, a weakening of the heart beat, paralysis, and death from asphyxia.

Treatment consists in the giving of such physiological antidotes as digitalis, ether, or atropine, with warmth and friction to stimulate circulation of the blood. Tannin and potassium iodide may be given in the hope that the alkaloid will be precipitated.

Hellebore.—All parts of this plant are poisonous, in particular the root, from which extracts are made. Toxic doses cause dysentery, salivation, vomiting, diuresis, with an action on the heart similar to that of digitalis.

Treatment consists in giving purgatives, demulcents and stimulants.

Delphinium.—Stavesacre, or *Delphinium staphysagria*, has four alkaloids present in its seeds. The powdered seeds are used against lice. The poisoning symptoms resemble those of aconite.

Corn Cockle (*Lychnis githago*).—This plant and those of the genera Saponaria, Arenaria, and Stellaria are poisonous. The grains may sometimes become mixed with cereals and be fed to animals. The poisonous properties are due to glucosides

of the saponin type, which in the body cause hæmolysis and paralysis. According to Cornevin, the toxic dose for the pig is 7 grains of the flour per lb. body weight. Large doses may be thrown out by vomition, but repeated small doses cause chronic poisoning. Acute poisoning shows itself by symptoms such as copious salivation, high temperature, anæmia of the mucous membranes, accelerated respirations, diarrhœa, muscular tremors, loss of motor and sensory powers, and death.

Treatment consists in removing the cause, giving purgatives, opiates and stimulants.

Meliaceæ.—This order comprises the Chinese umbrella tree (*Melia azedarach*), whose seeds are poisonous when fed to pigs. *Azadirachta indica* is a drastic purgative and anthelmintic. Poisoning causes gastro-enteritis with symptoms of nausea, vomiting, colic and tympanites, followed by diarrhœa, convulsions, uncertainty of gait, and great thirst.

Lathyrism.—Several varieties of the mutter pea (*Lathyrus sativus*, *L. cicera*, and *L. clymenym*) are known to be poisonous, and they may be brought to Great Britain with cereals. The seeds are the most dangerous part of the plant, and the poison is not destroyed by boiling or drying. Toxic conditions are produced more rapidly when the meal is fed rather than the whole pea.

Symptoms.—These are blowing, a staggering gait, with weakness in the hindquarters and later paralysis of the hind limbs, dyspnœa, blindness, and death. The symptoms of lathyrism are said to be produced when considerable proportions of the peas are fed for some time, and symptoms do not appear for a time after the feeding of the peas has been discontinued.

Post mortem.—Lesions are those of gastritis, with some enteritis. There is some congestion of the lungs, bronchi and larynx, with some congestion of the meninges.

Treatment.—The only treatment of any use is the removal of the offending food.

Lentil Poisoning.—*Ervum ervilia*, or the bastard lentil, has been accused of causing poisoning in pigs with symptoms of somnolence, coma, interrupted by muscular tremors, nausea and vomition. Pigs are said to acquire a tolerance after a time.

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Hemlock Poisoning.—The common *Conium maculatum*, or spotted hemlock, is poisonous especially in the green state, the active alkaloid being conine.

Symptoms.—Conine produces paralysis of the motor nerve endings, with symptoms of prostration, inability to move, coldness, slowness in breathing, livid mucous membranes, paralysis, especially of the hindquarters.

Treatment.—Emetics and purgatives. Tannic acid to remove the alkaloid; warmth and stimulants.

Dropwort Poisoning.—*Œnanthe crocata*, or the water dropwort, may cause poisoning if the roots are consumed by pigs. The juice of the dropwort has a very irritant effect on the skin. The active principle of dropwort poisoning is œnanthotoxin, with a rapid effect like cyanide poisoning. Cornevin gives the toxic dose of the root for the pig as 0·15 per cent. of the body weight. Symptoms of poisoning come on very rapidly, with foaming at the mouth, laboured respirations, spasmodic contraction of the limbs, delirium and death. Post-mortem lesions are few, and consist in some congestion of the nervous centres, whilst ecchymosed patches may be found in the abdominal viscera.

Wild Chervil.—Asses' parsley, or *Chærophyllum sylvestris* (*Anthriscus sylvestris*), is a common British member of the Umbelliferæ, and it has been said to cause poisonous symptoms in pigs. Pigs eating the green plant may show symptoms of paralysis, dilatation of the pupils, refusal of food and enteritis. An acute gastro-enteritis may be found on post-mortem examination.

Compositæ.—Members of this order, including *Xanthium canadense* (cocklebur), have been accused of poisoning in pigs. Pigs eating the seedlings of the cocklebur are reported to have succumbed soon afterwards.

Convolvulus.—*Convolvulus scammonia* and *Convolvulus jalapa* contain a glucoside, convolvulin and jalapin respectively. They are drastic purgatives, but in very large doses when they encounter insufficient bile they have an astringent effect. The convolvulus, bindweed or laplove is said to be dangerous to pigs. Animals eating the plant display loss of appetite, attempts at vomition, great dullness and death. A post-mortem examination may reveal a serous effusion into the

abdominal cavity, the intestines being devoid of solid matter, and containing only a little fluid and gas. The stomach will be full of green food containing convolvulus. There is also hyperæmia of the brain.

Cuscuta.—*Cuscuta europæa*, the greater dodder, causes enteritis and nervous symptoms in pigs. It is a greenish-yellow leafless herb. It causes trembling movements of the hindquarters, and may even lead to frenzy, leaving the animal exhausted afterwards.

Solanum (Potato Poisoning).—Unripe and green potatoes contain dangerous quantities of solanin. Old, rotten, and sprouting potatoes which have been kept for a long time are also dangerous, the alkaloid being most abundant in the eyes and skin; on boiling, the alkaloid passes into the water.

Poisoning with solanin therefore occurs when green, old, or damaged tubers are fed in long-continued and large quantities. Pigs fed on steamed potatoes which were budding show symptoms after a few days. These are loss of appetite, dullness, exhaustion, watery diarrhœa, low temperature, and a comatose condition.

Post-mortem lesions are those of enteritis, with congestion of the cerebral membranes.

Treatment.—Tannin and linseed tea may assist recovery in some cases.

Nicotine.—The tobacco plant, *Nicotiana tabacum*, contains a poisonous volatile alkaloid, nicotine. Infusions of tobacco juice are sometimes used for spraying fruit trees, and as parasiticides.

Symptoms.—These consist of vomition, nausea, blowing, and later slowing of respirations, low temperature, coma, and a paralysis of hind-legs.

Post-mortem.—Inflammatory patches are found in the stomach and intestines. There is ecchymosis of the lungs and mitral valve of the heart, the right ventricle is filled with dark blood, the capillaries are empty, and the flesh has an anæmic appearance.

Treatment.—Potassium bromide, dilute alcohol and strong coffee have all given good results.

Digitalis.—The common foxglove, *Digitalis purpurea*, in all its parts contains the glucosides digitalin, digitoxin, digitalein, and digitonin, all except the last being poisonous.

Neither boiling nor drying deprives the plant of its activity as far as poisoning is concerned, and Cornevin gives the toxic amount of the green leaves for pigs as *½ to ¾ oz.* Digitalis is only slowly eliminated from the body, and is a cumulative poison.

Symptoms.—Pigs become languid and sleepy, the appetite is lost, vomition is attempted, and small quantities of fæces may be passed repeatedly. There is evident strain in passing urine. In recovered animals the effects do not pass off for a week or more.

Post mortem.—The lesions found include an acute inflammation of the stomach and intestines, congestion of the kidneys, and an empty bladder. In digitalis poisoning the abdominal viscera are usually healthy, the lungs being engorged with dark venous blood and the auricles of the heart are greatly distended.

Treatment.—Purgatives, mucilaginous draughts, and stimulants. Atropine may be given to counteract the irregular heart action.

Castor-seed Poisoning.—The castor seed contains castor oil obtained by pressure or extraction, and the residue left over after the oil has been extracted contains ricine, the active toxin. Another poison, crotine, is obtained from *Croton tiglium*, whose seeds resemble those of *Ricinus communis*, the castor-oil plant, except that the latter seeds are mottled and can be rendered atoxic, whereas those of croton are a dull brown.

Symptoms.—Poisoning will not be apparent until several days have elapsed. There is loss of appetite, abdominal pain, vomiting, and in the case of croton-seed poisoning severe purgation.

Ricine immunity in recovered animals is characteristic, and by increasing doses an animal may be made tolerant of enormous overdoses. The ricine antibody can confer immunity on a second subject, but it is specific for the ricine toxin.

Poisonous Foodstuffs, etc.

Animals do not normally consume poisonous plants, but pigs kept in compounds completely denuded of grass may eat any green food, even poisonous plants, but many animal

foods are popularly assumed to have poisonous properti when the ill-effects are due to the preparation or condition the food rather than to any poisonous ingredient.

Cocoa Meal.—This is the residue left after the extracti of cocoa butter from the cacao bean. As it is a waste produ of the margarine industry, some attempts have been made use the meal as an animal food. The oil is extracted fro the whole bean by hydraulic pressure at a temperature 160° F. The residue, when ground into a meal, consists the following: Water 13·5 per cent., protein 23·2 per cen oil 5·6 per cent., carbohydrates 42·6 per cent., fibre 9·1 p cent., and ash 6·0 per cent. Its theobromine content 2·8 per cent., and it also contains 1·4 per cent. caffeine. has been found impracticable to remove the theobromine c a commercial basis. Experiments to find whether the coco meal with its theobromine unextracted was of any value a feeding stuff when fed at low levels, and whether its in clusion in war-time diets of fattening pigs was justified, we carried out by Braude. The toxicity of cocoa meal wa proved when it was fed at 7½ per cent. of the ration. At 5 pe cent. level the material was not noticeably toxic, but the was no advantage in including it in the diet of fattening pig as its nutritive value seemed to be very small or counte balanced by the non-apparent toxic effects of the theobromin at this level. Braude states that where smaller quantiti than the 7½ per cent. did not appear to exert a toxic effec there was a possibility that the normal fattening period wa not long enough to allow the symptoms to show.

Symptoms.—Slow rate of growth was observed in pigs fe on a ration containing the meal, as compared with control Animals refused portions of their food, the refusals growin as the experiment progressed. Unthriftiness, lethargy an scour (dark diarrhœa), progressive weakness with high tem peratures were noticed. Death occurred in some pigs at abou the fifteenth week.

Post mortem.—Extensive areas of pneumonia and pleuris in both lungs, excessive pericardial fluid, with congestion o the liver, stomach and large intestines, were the lesions foun in all cases examined. A pig whose diet was changed b eliminating the meal recovered in ten days. In slaughtere

animals congestion and red hepatization of the anterior lobes of the lungs were observed, whilst a few had slightly inflamed stomachs and intestines. (The lung conditions described are very common in pigs, and are probably secondary in this instance.)

Braude concluded that the meal was toxic for older pigs when included at a 10 per cent. level in the diet, and that probably the quality of the total ration played a part in determining how soon the adverse factors caused by the cocoa meal in poor quality war-time feeding mixtures increased its disadvantages.

Cottonseed Poisoning.—Pigs are said to be particularly susceptible to cottonseed poisoning, especially if the ration happens to be deficient in calcium, iron and protein, whilst cottonseed cake or meal containing undecorticated cotton cake may be very harmful, as the husks of the seed contain a large proportion of indigestible fibre. The toxic principle is an active gossypol, which can be rendered inactive by heating the cottonseed cake at 100° C. for one hour, or 70° C. for two hours. Sometimes the symptoms attributed to cottonseed poisoning may be due to contamination with castor beans or metals. The symptoms are said to be an impaired appetite with difficult respirations, some disturbance of equilibrium, blindness, weakness in the hindquarters, followed by convulsions and death within about an hour or less from the first onset of the symptoms.

Post mortem.—Lesions are found in the intestinal mucosa in the form of a diffuse swelling and a catarrhal inflammation of the gastric and intestinal mucous membrane, with a patchy hæmorrhagic inflammation throughout the small intestines. The mesenteric lymph glands are enlarged and congested, and the kidneys may be swollen and hæmorrhagic. There may be some effusion into the pleural cavity, and the trachea may contain some frothy blood-stained fluid. The lungs may be œdematous and congested, and the heart enlarged and flabby.

Treatment consists in a change of diet and the administration of laxatives.

Fodder-beet Poisoning. Illness in pigs following the excessive feeding with fodder-beet, and feeding of pulped fodder-beet without tops up to 12 lb. daily plus a meal ration, has been held

responsible for symptoms of poisoning, and particularly if the beet is sprouting.

Symptoms.—Poor development with lack of condition, plus some diarrhœa which may even be copious, but not offensive in smell. Some nervous symptoms are also reported, with secondary pneumonic lesions.

Treatment.—Remove offending food. If white beet is responsible change over to the red-skinned variety, non-sprouting and clean. This should be done after the diarrhœa has disappeared.

Ground-nut (Pea-nut or Earth-nut) Meal.—If fed without the addition of some minerals and vitamin supplements, such as calcium carbonate, lactate or borogluconate, and cod-liver oil in small quantities, ground-nut meal is apt to cause digestive disturbances and even death in young pigs, particularly in those between the ages of weaning and about eighteen to twenty weeks. Older pigs seem to stand the ground-nut meal in the food better than young animals. If ground-nut meal is substituted for some other protein in the ration, the pigs will eat it without any trouble for a few days, when some of the younger pigs may be found dead, whilst others are affected with diarrhœa and even dysentery.

Post mortem.—The lesions are similar in many respects to those found in cases of cottonseed poisoning, the patchy inflammatory areas throughout the intestinal tract being most marked. The stomach is often found impacted with undigested meal.

Treatment consists in changing the diet at once, particularly for the younger pigs, and substituting some protein such as fish meal. The addition of calcium, iron, copper, cobalt, manganese, and other trace elements to the ration, and a small dosing with cod-liver oil via the food, are indicated for any pigs where ground-nut meal forms part of the ration.

Soya Bean.—Soya-bean cake has been accused of causing damage to cattle chiefly, setting up symptoms similar to those of bracken poisoning. In such cases cake extracted with trichloroethylene appeared to have caused the trouble, and cake extracted with naphtha is harmless. It is thus possible that the poisoning attributed to soya-bean cake was in reality caused by the trichloroethylene.

Brewers' Grains.—Brewers' grains and distillers' grains have been held responsible for poisoning, but the addition of common salt to preserve distillery sludge, etc., makes the food harmful. Grains, being liable to fermentation and acidity, ought not to be fed too liberally, and they should be mixed with other foods.

Acorns.—Acorns have been blamed for the deaths of pigs, and they have also been suggested as a cause of liver cirrhosis in the pig. The ingestion of large quantities of acorns is said to set up a gastro-enteritis and to give the stomach a tanned appearance.

Treatment consists in giving oily purgatives, linseed tea, gruel, and sodium bicarbonate.

Chilean Peas.—Chilean peas have been mentioned as a cause of poisoning in pigs. The cases which came under the writer's notice were reported upon by Professor Clough. About eighty pigs aged from five to six months were fed with a mixture containing 12½ per cent. of a food described as Chilean peas. A number became ill and died. Post-mortem examination showed a gastritis with some patchy enteritis. No poisonous substance was detected in the viscera sent for analysis, but the peas on incubation with water yielded 0·018 per cent. of hydrocyanic acid (or 1¾ grains per pound). Some of the seeds from the sample sent were grown at Kew Gardens, and from the plant raised it was found that the sample consisted mainly of forms of the common vetch (*Vicia sativa*) and the purple vetch (*Vicia atropurpurea*). The seeds were screenings of Chilean barley from South America, and the seeds of the common vetch are said to be injurious to pigs, two glucosides being present in *V. sativa*, one a cyanogenetic glucoside vicianin and the other vicine, which on hydrolysis yields divicine, an oxyamino derivative of pyramidine.

The only satisfactory treatment consists in withdrawing the offending food.

Blighted Barley.—Fungi and bacteria are associated with blighted or scabby barley, and may cause symptoms of illness in pigs. These are loss of appetite, some listlessness and weakness, with vomition. The principal fungi are said to be Alternaria, Helminthosporium and Fusarium, and a water-

soluble, thermostable toxic principle has been isolated from *Fusarium graminearium*.

Ergot Poisoning.—Ergot-contaminated food is held to be the cause of a form of agalactia in sows. Nordskog and Clark found this condition in Montana due to ergot-contaminated barley. Shone, Philip and Christie have seen a similar condition in Rhodesia, in which the fungus Ergot was parasitic on the grain of the bulrush millet (*Pennisetum typhoides*) which grows in that country under the native name of *Munga*. Laboratory examination of the ergot fungus shows the alkaloids to be a group of water-soluble alkaloids quite distinct from the ergotoxine–ergotamine group, and the ergometrine group normally found in ergot. Now water-soluble alkaloids penniclavine, agroclavine and clymoclavine have been isolated by Stoll and others in 1954, from the ergot found on *Pennisetum typhoides*.

Symptoms.—Pregnant sows fed on this contaminated food failed to develop the hypertrophy of the mammary glands normally associated with farrowing. The average gestation period was a few days shorter than normal, and the pigs born died of starvation due to lack of nourishment from the sow. The birth of weakly piglets, and a high proportion of still-births, have also been attributed to feeding with this contaminated food.

Treatment.—The diet of pregnant sows should be carefully examined for ergot-contaminated cereal, and obviously the offending food removed from the ration.

Swill, Garbage, Tankage, etc.—Swill and garbage, etc., may be fed to pigs in large quantities during war-time, and some of the dangers attendant upon such feeding have already been mentioned. Swill itself is not poisonous, but may contain excessive quantities of poisonous metals, and swill fed unboiled has been found to spread foot and mouth disease amongst pigs. Under the *Foot and Mouth Disease (Boiling of Foodstuffs) Order* of 1932 all foodstuffs containing material of animal origin or having been in contact with such material must be boiled for one hour before feeding to livestock. This not only ensures the destruction of harmful elements, but also renders the food, particularly swill, more palatable and useful as a pig food.

In North America it has been found that the incidence of

trichinosis is much less in pigs fed on boiled swill or garbage than in those fed on the raw material.

Another substance reputed to cause some ill-effects in pigs is *cod-liver oil*, which German writers have found to cause dystrophy of the liver and death. Excess cod-liver oil may also affect the vitamin E metabolism and lead to muscular dystrophy. The cheaper brands of cod-liver oil, if fed regularly and in excessive amounts to bacon pigs, give the fat an oily and fishy taste. After slaughter the fat assumes a chocolate-brownish colour and the bacon tastes "fishy." *Turnip* and *mangold tops* have also been blamed for pig deaths. The plants are said to generate hydrocyanic acid on being heated, but the symptoms shown are not those of hydrocyanic acid poisoning. If the germinating tubers of *Jerusalem artichokes* are fed to pigs they may cause vomiting, lack of appetite, diarrhœa, and staggering gait. Dead pigs show some lesions of gastro-enteritis. Affected pigs may recover when the tubers are withdrawn from the food. *Kale* if fed in unrestricted quantities may cause indigestion and scour. It should be pulped and fed gradually, so as to avoid these ill-effects.

Sugar-beet tops must be fed with care to pigs, and particularly to nursing sows. Excessive use of beet tops leads to diarrhœa in the young pigs, and even to death. Another foodstuff not usually fed to pigs, but which may occasionally find its way into the trough, is parsnip or parsnip tops. Skin discoloration and the sloughing of areas of epidermis is a sign of poisoning from this source.

Anaphylactic Shock

An exaggerated susceptibility to certain proteins may occur in animals when an injection of some protein substance is made after an interval since another injection of the same protein was given. Symptoms ot intoxication may occur, and these may be severe enough to cause death. All proteins give rise to fractions when they are chemically disrupted, and some of these fractions are poisonous. The first injection may stimulate the body mechanism to produce a means of destroying the protein used, and so to protect the body against minute amounts likely to find their way into the system in

a natural infection. When a considerable amount of the protein is injected at one time, the amount of disrupted protein in the body may then become so great as to cause symptoms of intoxication and even death from what is termed "anaphylactic shock."

Anaphylaxis can thus be induced by using any kind of protein foreign to the body of the particular animal. The reaction is induced only by the protein to which the body has already been sensitized. Such a shock may occur when certain biological products, such as inoculating fluid made from horse serum, are used on an animal of another species—*e.g.* a pig. The condition needs a special mention here, as there is a tendency for laymen to purchase and use certain sera for pigs, often with disastrous results, for which the serum is blamed.

A similar hypersusceptibility to non-protein substances occurs in diseased animals and others, especially in those harbouring disease germs. This hypersensitiveness disappears with the disease. The injection of extracts of the causal organism of the particular disease may set up a reaction in such animals. This is termed an allergic reaction.

Snake Venom Poisoning.—It is rare for pigs to be poisoned with snake venom, but cases sometimes occur in which young pigs are killed by poisonous snakes. The adult pig is generally well protected by skin and fat, unless the bite occurs directly into a blood vessel, and it is the young sucking pig running around with the sow that is most likely to be poisoned by snake venom. Few cases are ever recorded, as the young pig is not actually seen when bitten, but the dead body is found some time later and death often attributed to some accident. Cases are sometimes mentioned in the popular press in Britain of young pigs being poisoned by the bites of adders or vipers, and in those rare opportunities for post-mortem examination of the carcases of sucking-pigs reported to have died from viper venom it is very difficult, and even impossible, to detect any bite marks. This is not surprising as the marks made by the fangs of the British viper (*Vipera berus*) are as small as a fine needle, and the most careful search and dissection will not reveal them in the skin of a pig with its fatty subcutis. In cases known to the author, the animals reported to be poisoned

were sucking pigs running around with their mother in compounds near some woodland. The little pigs could run out of the compounds and roam at large. One of the litter evidently disturbed a viper under some bushes, and came running back to its mother squealing and very frightened. Within an hour the animal was dead. Post-mortem examination failed to reveal any apparent cause of death. Some days later a little pig from another litter died under similar circumstances. A very young dog puppy wandering into some bushes near this spot was heard to yelp and then came running back to its owner terrified. In less than one hour it died suddenly. Again there was no apparent cause of death found at post-mortem examination, but adders were known to be present in the neighbourhood.

The venom of the poisonous type of snake is composed largely of proteins and enzymes which vary among snakes of the same genus. The active constituents of these venoms may be classified as Neurocytolysins, Hæmolysins, Hæmocoagulins, Proteo- and Cyto-lysins. Neurocytolysins are slow acting, and have a systemic effect on respiration, circulation, vision or other specialised functions. (In S. American Rattlesnakes, Coral snakes, Indian Cobra, African Mamba and others.)

Hæmolysins act on both red and white blood cells, and complicate the local symptoms produced by proteolysins and cytolysins in the earlier poisoning stages. Lysis of the red blood cells causes reduced oxygen intake to the tissues. (Cobra, Daboia, Texas Rattlesnake, S. American Urutú and Fer de lance.)

Hæmocoagulins have often a trypsin-like enzyme which reacts with prothrombin to form thrombin. Others have a papain type enzyme reacting with fibrinogen to precipitate fibrin and produce coagulation of the blood. (Trypsin-group: S. American Jararaca, Fer de lance, and some coral snakes. Papain-group: Florida Rattlesnake, S. American Cascarel, Jararaca and Fer de lance.)

Proteolysins and Cytolysins cause local swellings and discoloration, necrosis and pain. The former dissolve the tissue proteins and so prepare the way for the destruction of the cell structure by cytolysins. (Vipers, pit-vipers, N. American Rattlesnake, S. American Fer de lance, Jararaca,

jararacuçú and urutú, Japanese Habú, Asiatic and Malayan green pit-viper, Indian Daboia.)

Treatment.—This is of little avail in pigs, as it is generally the discovery of a dead animal that gives the first indication of trouble. The normal treatment of snake bite is anti-venom injection, injections of saline or glucose solutions, or drugs like caffeine or strychnine. Rubbing potassium permanganate into the excised part is of no use. A tourniquet applied to a limb and suction to the bite mark, if it can be found, may be helpful. The snake's breeding ground should be cleared and further trouble prevented by destroying any snakes in the vicinity of the pig pens.

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Chapter 16

POST-MORTEM METHODS

THE work of examining dead pigs to ascertain the cause of death is often carried on in conditions which would make a medical man cry out in anguish, and this makes it all the more essential for the veterinary surgeon to maintain certain standards of cleanliness when performing post-mortem examinations. The owners of dead animals often seem to think the veterinarian capable of opening up a green and stinking dead pig without making the slightest provision for the operator to even wash his hands, to say nothing of disinfecting himself. For this reason it is advisable for the surgeon to provide himself with a supply of disinfectant, soap and water, towel, overalls, rubber boots and gloves, together with some sharp, strong post-mortem knives and a saw. A sterile swab and a few clean microscope slides are also useful, and a good strong steel hook with a handle about a foot long will also be a great help in eviscerating carcases. The possibility of anthrax, foot and mouth disease or some infectious condition being present in the dead animal should render a thorough disinfecting of boots, hands, instruments, etc., a necessary ritual at every post-mortem examination.

It is not always possible to take down notes as the operation proceeds, but it is always best to record findings without delay, if possible. Where this is not possible, the operator should get into the habit of working systematically, and of noting similar points, in the same order, at each post-mortem examination he makes. This mental discipline will enable him to jot down the essential points after the operation has been concluded, without fear of missing something which may prove of importance later on. The name and address of the owner of the dead animal, the time and date when the post-mortem examination was made, as well as the species of animal, should be recorded before commencing operations on the dead body.

Among things worth noting at this stage, then, are the following:

(*a*) The breed of pig. The general conformation, shape, colour, snout and ears, should help in arriving at the breed. If only a skeleton is available, or decomposition is very advanced in the carcase, then the nearest one may be able to get to *breed* is that the animal belonged to the long-nosed or to the short-nosed varieties. If the dorsal vertebræ and ribs are available, then the long-nosed breeds may be further analysed. Whereas pigs normally possess fourteen pairs of ribs, breeds like the Welsh, the Large White and Large Black usually have high rib counts. Rib counts carried out on pigs of various British pure-breds show a remarkable constancy in placing the three long-nosed breeds mentioned among those with over fourteen pairs of ribs.

(*b*) The sex of the animal can be easily determined, and here one should be careful to find out if any castration or spaying operation scars are visible. The animal may be a boar, sow, stag, gilt, spayed gilt, or a hog. As pig castration is often performed by quacks whose standard of operative cleanliness is notoriously foul, the surgeon would be well advised to pay some attention to any castration or spaying wound scars, as they may have some relationship to any lesions he finds in the peritoneal cavity or in the flank later on.

(*c*) All identification marks on the body should be especially noted. These may include colour, ear tags, ear tattoo marks, paint marks, or skin scratches. The latter marks, made with a blunt knife, are often used for pig marking, especially when it is necessary to mark the pig whilst it is alive, so that the mark can be visible on the carcase after slaughtering and passing through scalding tanks, dehairing machines, and other hazards

(*d*) The approximate age of the animal may be obtained from an examination of the teeth and the size of the carcase. After opening up the body, if the skull is not available, the ossification of cartilage, especially in the sternal, sacral and pubic regions, will help to determine whether one is dealing with an aged animal or not. In an animal up to six months old it should be possible to slit the pubic symphysis with a knife without any very great effort, assuming, of course,

that the operator takes care to insert the point of the knife into the cartilage in the centre line.

(*e*) The general condition of the pig, as to nourishment, will become more apparent when the carcase is opened up, unless the animal is very emaciated. This applies especially to tympanitic carcases.

The points mentioned in the foregoing paragraphs need not necessarily be noted in the order they are given here, but breed, age, sex, colour, identification, are headings that always pass through the mind of anyone who is at all accustomed to performing post-mortem examinations upon animals. If the owner knows the time of death of the animal, that should be noted also, and it seems hardly necessary to add that any information the owner can give relative to the animal's life may or may not be of assistance in enabling the surgeon to assess the cause of death.

The body temperature, the presence of putrefactive changes, rigor mortis, are all of help in trying to estimate length of time the animal has been dead. The position in which the body lies may also indicate either a sudden death or one preceded by much struggling. Evidence of fighting, a common cause of fatalities in pigs, especially where a strange pig is mixed with pigs of another litter, will easily be visible in the white breeds by the bite marks on the skin, especially about the ears. The skin lesions of swine erysipelas are also visible in white pigs, but these may have to be felt for in the black breeds. The condition of the skin of the pig is a useful indication of the state of the body as a whole, and diseases like swine fever, paratyphoid, erysipelas and variola are some of the conditions which carry skin lesions. It may be advisable for the surgeon to scrape off some of the bristles, especially in a black pig, before he commences any cutting into the carcase. If any hot water is available, then some bristles with the superficial layer of the skin can be scraped off from a patch on the flank or ham. The patch need not be bigger than a man's hand, and it will help the surgeon to obtain a better idea of the state of the skin in a black pig than by feeling in the dark.

Having ascertained that the chances of finding anthrax or foot and mouth disease in the carcase are remote, the operator proceeds to make his first incision, having laid the body on

its back if possible, abdomen upwards. As soon as the carcase is opened, the organs can be seen in their natural sites, whilst any fluid in the body cavities remains there. This is naturally apt to drain away if the carcase is examined whilst lying on its side, or even hanging by the hind-legs.

To open the carcase the incision should be made along the middle line of the belly, commencing at the perineum and extending to the symphysis of the lower jaw. To start cutting at the head or sternum and work backwards is usually the sign of the amateur. There is no necessity to flay the pig, as there are two layers of subcutaneous fat before one gets to the abdominal musculature. A good bold incision as mentioned will suffice to open up the skin, but to expose the abdominal cavity will require a deeper cut, and before doing this the operator must open into the peritoneal cavity gently. A small hole just anterior to the pelvis will let out any foul gases, and enable the surgeon to insert his knife carefully into the cavity, so as to cut in an outwards direction, and thus avoid the amateur's bugbear, cutting the intestine or stomach, and liberating the contents all over the abdominal cavity. The steel hook, previously mentioned, will here come in useful to raise the abdominal wall so that it does not rest on the intestines. This lessens the chance of the intestine being accidentally cut and the contents liberated.

The deep incision to open up the abdominal cavity can only be continued as far forward as the xiphoid cartilage. Here the sternum proves an obstacle for the knife. Over this the cut should be made deep down to expose the bone, and continued forward towards the jaws. The sternum should then be sawn through, commencing at the anterior part and working back towards the xiphoid, taking care to avoid holding the saw too vertically, otherwise it will penetrate the thoracic cavity and damage the organs, before they can be properly examined.

It may be necessary, in an aged animal, to use a saw to open up the pubic symphysis. In a young animal this can be done by inserting the point of the knife into the cartilage in the middle line, tapping the knife handle with the hand to drive the point in, and then pressing the knife forwards and downwards, when the cartilage will easily cut through.

As far as very young pigs are concerned, it will not be necessary to use a saw at all. The foregoing remarks apply to adult pigs. The knife can be used for the sucking pig and weaner. In these young animals the chest cavity can be further exposed by cutting the ribs on either side and deflecting portions of the chest walls. To avoid accidentally cutting the intestines or stomach when opening up the belly, make the first breach into the cavity just in front of the pelvis. Into the breach so made insert the first and second fingers of the left hand to act as "guides," and place the knife blade in between these fingers. As the knife cuts, so the fingers lift the abdominal wall away from the intestines and stomach. Care should be taken when cutting open the thoracic cavity in very young pigs, as the heart may easily be damaged, lying as it does so close to the sternum.

Having opened the body up, the surgeon should then make his first examination of the abdominal organs as they remain in position. He can note any liquid contents of the cavity, and if he wants a still better view, he may cut the flanks in a lateral direction. The knife should be inserted carefully into the abdominal cavity and the flanks cut at right angles from the middle line, down towards the lumbar vertebræ. Deflecting the tissues back will expose still more of the abdominal organs as they lie in position. The pelvic cavity can be further exposed by spread-eagling the hind-legs forcibly apart.

The organs can then be removed one by one for examination, starting with the urinary and sex organs, followed by the spleen and omentum, then the stomach and bowels. As each organ is removed from the body it should be carefully examined and its condition noted. The organs should then be laid down separately, and not mixed together in a heap, until the post-mortem examination is concluded. To remove the intestines and stomach, with their contents, the anus should be cut out first so as to allow the rectum to hang freely. In a large pig it may be advisable to tilt the body on its side to allow the intestines to fall out on to the floor, when the mesentery can then be cut carefully and the intestines spread out on the floor for examination. It is a useful practice to open up the cæcum as a routine measure in all pig post-mortem

examinations. The stomach and pancreas will follow the intestines out of the body cavity, the œsophagus having been severed as far away from the stomach as is possible.

The gastro-intestinal contents should be examined after the organs have been cut open. If running water is available, all the better, as the mucous lining of the bowel can then be re-examined after washing away the fæces. The ileum, cæcum and part of the colon are the parts of the alimentary canal which, with the stomach, are likely to show pathological lesions, so that an endeavour should be made to open up these parts and examine them free of fæces.

Having removed the organs mentioned, the liver and kidneys will be exposed, the latter embedded in their fatty covering. This will be opened up and the kidneys removed for examination, particularly as petechial hæmorrhages are frequently found here in swine fever. The suprarenal bodies will be examined with the kidneys, whilst the condition of the peritoneum can be noted, as can the presence or absence of the peritoneal fat usually found in pigs. The lymph glands can also be cut open and examined: the supramammary or inguinal glands, the iliac glands on the brim of the pelvis, and the sublumbar glands will easily be exposed and inspected at this juncture.

The only organ remaining in the abdominal cavity at this time should be the liver. The diaphragmatic surface can be examined for any adhesions, after which the diaphragm is cut in a semicircular fashion from sternum to spine, on each side. Grasping the pillars of the diaphragm with the left hand, the liver, lungs and heart can be removed complete in one operation, without damage. The trachea with œsophagus attached will come away with the lungs, the only cut necessary will be to free the larynx and œsophagus from the pharynx.

The liver is one of those organs in which post-mortem changes occur within a short time after death, and in very hot weather the whole appearance of the organ may be changed, the external surface being emphysematous, and the substance of the liver on section appears putty-like. If there is any difficulty in removing the pancreas with the stomach, it can easily be taken out of the body with the liver. The heart and lungs will need most careful examination, and here again a

good wash in running water will materially assist the surgeon in examining the pleura for any adhesions. The heart should be cut open and the valves examined in view of the prevalence of endocarditis in the pig.

The trachea is slit down for examination, and so is the œsophagus. In examining the head, the tongue should be exposed by slitting the cheeks, or by incising along the borders of the lower jaws. The submaxillary lymph glands at the angle of the inferior maxilla, the retropharyngeals and tonsils, as well as the cervical and presternal glands, can also be examined at this stage. Particular care should be taken in inspecting the neck and jowls for any œdematous or jelly-like swelling subcutaneously in view of the possibility of anthrax being present. (The first incision from tail to head will have opened up the neck region.) The fact that in England, in particular, agriculturists and others, whose knowledge of animal pathology is very minute, often try their hand at opening up a dead animal makes it unfortunately necessary to emphasize that this work should be left strictly to the veterinary surgeon, whose job it is.

The brain presents a difficulty, and to examine this organ the head will best be severed from the carcase, and then sawn down the middle from poll to snout. This will expose the brain and enable the surgeon to examine the two sides, as well as the pituitary and the pineal body.

If it is desired to examine any of the bones of the body, then the surgeon will be required to do some careful dissection.

The surgeon will be on his guard throughout against confusing post-mortem changes with pathological lesions. Putrefactive changes commence directly the animal dies, and proceed with the greatest rapidity in the abdominal organs, the commonest change being the green colouration, tympanitis, congestion of those parts in contact with the ground, and gravitational congestion in one lung. The cornea will show a parchment-like wrinkling.

A few microscope slides may have to be prepared, and if a smear of blood from a vein of the ear is required, it is best to take it from the ear nearest to the ground. Use can be made of refrigeration in the preservation of organs, and where circumstances allow, of carcases also. Packing with artificial

snow can be resorted to in sending material away for examination. It is best to send whole organs rather than portions thereof, and all pathological material sent by post or rail should be very well packed in waterproof containers. Plastic bags are now available in which pathological material can be wrapped, in addition to the normal packing materials.

If a bacteriological examination of the material is required, it should be sent away fresh and not soaked in any preservative material beforehand. Pathologists will sometimes accept organs or parts thereof soaked in a 10 per cent. formalin solution before packing, but it is often better to deep freeze and despatch the material in a frozen state, or failing such methods, to wrap the meat in gauze soaked in 10 per cent. formalin solution. Unweaned pigs can often be sent intact to the laboratory, and if road transport is not immediately available, passenger rail service should be used, the laboratory being notified by telephone or telegram beforehand. Full details of the case should always be sent to the person making the laboratory examination, and again we must stress the care in packing the material. It seems hardly necessary to add that the veterinary surgeon who cares enough for pathology to build up his own laboratory can often be of great service to his clients, and amass great knowledge himself.

Appendix 1

THE TUBERCULIN TESTING OF PIGS

WHILE the intradermal tuberculin test can never be regarded as an infallible diagnostic test in any species of animals, the application of such a test to pigs, especially on a herd basis, can provide a practical method of control of the disease. The sensitivity to tuberculin of pigs infected with avian and mammalian strains of tubercle has been examined under critical experimental control by Luke (1952). Certain criteria must be observed from the outset:

(*a*) The tested animal(s) must be identified by ear tagging, notching or tattooing, at the time of test.
(*b*) All pigs over 8 weeks of age should be tested.
(*c*) The tests should be at 6-week intervals until reactors are eliminated and thereafter at 6-monthly intervals.
(*d*) New purchases should have passed the test within 28 days prior to sale, otherwise they should be retested before introduction into a tuberculin-tested herd.
(*e*) Testing should be accompanied by rigid measures of hygienic control.

Choice of Test.—The single comparative intradermal test applied to the skin at the base of the ears is likely to provide the maximum information and is therefore the test of choice. It is generally recommended that the site of injection be the loose skin at the base of the ear on its posterior aspect over the firm conchal cartilage. Other workers advocate the skin at the anterior border of the ear about one-third up from the base, but the site will naturally depend upon the breed of the animal—*i.e.* the carriage of head and ears—and the convenience of the operator.

Technique.—When the back of the ear is used, the injections can be made without the handling of individual pigs, especially if they are crowded into a box or dung passage a short while beforehand. Adult pigs can usually be approached quietly

while they are recumbent or the operator can interpose a boar board or sheet of galvanised iron between himself and a more fractious animal.

The most convenient type of syringe is the dental pattern which can be held and operated with one hand. The piston shank is graduated and each dose is estimated by turning the set screw on the threaded stem. Some positive means should be adopted to differentiate the avian from the mammalian tuberculins. Interchangeable Schimmel-type needles provide a ready and quick method of replacing broken and blunted needle-points. A needle of not more than 0·5 cm. in length should be used.

The tuberculins employed should be P.P.D. (Weybridge) of the same strength as used for the testing of cattle. Where it is immaterial to differentiate between avian and mammalian infection, the tuberculins can be mixed and injected into one site, but it is more satisfactory to adopt separate injections for each tuberculin, one into the skin of each ear.

The operator stands behind the pig's shoulder, and inserts the needle into the skin. 0·1 ml. of tuberculin is injected mainly into the skin and possibly the subcutaneous tissue. An experienced operator can make both injections simultaneously with a syringe held in each hand.

The result is read 48 hours later, a trough of food being offered and the ears observed as the pigs feed. McDiarmid (1956) states that no measurements need be taken as there is a high degree of specificity with this test, cross allergy is practically absent and avian and mammalian reactions can readily be identified. Positive reactions vary from slight œdematous swelling to acute inflammatory reaction with central necrosis. Any evidence of œdema must be regarded as positive. Some animals may show a marked systemic reaction and be obviously ill. All reactors must be eliminated from the herd at once.

REFERENCES

Lukl, D. (1952): *Vet. Rec.*, 64, 344.
McDiarmid, A. (1956): *Ibid.*, 68, 298.

Appendix 2

POSOLOGY

The doses in the following tables represent the total daily amounts which should be given. In some cases, the whole dose is administered once daily and in others it is split into portions which are given at regular intervals during the day. It will be appreciated that dosage is also governed by such factors as the age, condition and size of the pig and the acuteness or severity of the clinical signs.

Chemotherapeutics

A. Antibiotics

Penicillin preparations—Parenteral	4,000-20,000 units/kg.
Penicillin preparations—Oral	3·5 times parenteral dose
Streptomycin	5·0-10·0 mg./kg.
Oxytetracycline—Parenteral	4·4-11 mg./kg.
Oxytetracycline—Oral	10·0-100 mg./kg.
Tetracycline	2·2-4·4 mg./kg.
Chlortetracycline—Parenteral	4·4-11·0 mg./kg.
Chlortetracycline—Oral	0·05 G./kg.
Chloramphenicol	11·0 mg./kg.
Neomycin	0·75-1·0 G.
Erythromycin	1·0-3·0 G.
Novobiacin	1·0-2·0 G.

B. The Sulphonamides

Sulphanilamide	0·2 G./kg.
Sulphapyridine	*0·15 G./kg.*
Sulphadiazine	0·2 G./kg.
Sulphamerazine	0·2 G./kg.
Sulphadimidine	0·2 G./kg.
Sulphathiazole	0·2 G./kg.
Sulphafurazole	0·2 G./kg.
Sulphaguanidine	0·1-0·3 G./kg.
Phthalylsulphathiazole	0·1-0·15 G./kg.
Succinylsulphathiazole	0·1-0·15 G./kg.

C Miscellaneous Chemotherapeutics

Nitrofurazone } Furazolidine }	(Curative)	1 kg./½ ton feed
	(Prophylactic)	1 kg./2 tons feed

D The Vitamins

Aneurine hydrochloride	2·5-15·0 mg. daily
Riboflavine	2·0-3·0 G. per ton of feed
Nicotinic acid and nicotinamide	0·1-0·9 G. daily
Cyanocobalamine (tonic)	0·5-1·0 μg/kg. daily
Pantothenic acid	11-13 G. per ton of feed
Choline	900-1,000 G. per ton of feed
Vitamin A	600 i.u./kg.
Cod-liver oil	4-15 ml. daily
Vitamin D	6-10 i.u./kg.
Vitamin E	0·5 G. daily minimum

E Biological Products—Hormonal Preps.

Cortisone	0·1 G. per day
Hydrocortisone	20 0-80·0 mg. per day
Prednisolone	5 mg.-15 mg. per day
Thyroid	1·0-2·0 mg./kg.
Thiouracil	0·2-0·6 G. per day

Vaccines and Sera

	Vaccine	Serum	
		Prophylaxis	*Therapy*
Anthrax	0·5 ml. (5 million viable spores)	10-20 ml.	50-100 ml.
Blackleg ..	2-5 ml.	10-20 ml.	100-200 ml.
Tetanus	—	500-1,500 units	50,000-150,000 units.
Hæmorrhagic septic.	2 5 ml.	10-20 ml.	50-100 ml.
Swine erysipelas (AT)	2·0 ml.	10-20 ml.	20-50 ml
E. coli .. .	2 5 ml	10-20 ml.	50-100 ml.
Swine fever (Cryst V)	5-10 ml.	30-100 ml.	—

F General Preparations

1 Alimentary—

Liquid paraffin	60-300 ml
Calomel	0 3-2·3 G.
Phenolphthalein (by i/musc. inj.)	1-2 G.
Carbachol (as 1 : 1,000 sol.)	0·5-2 mg.
Tannic acid	1·3 G
Aluminium hydroxide gel	8 ml.

Aluminium hydroxide gel (dehydr.)	0·6 G.
Kaolin	15-30 G.
ii. Anthelmintics—	
Arsenic trioxide	16·0-48 mg.
Liq. Arsenicalis	0·6-5 ml.
Chenopodium oil (in castor oil)	0·8 ml./kg.
Santonin	0·13-0·6 G.
Piperazine hydrate	100 mg./kg.
Tetrachlorethylene	2·5-10 ml.
Sodium fluoride (in dry food)	0·33 G./kg.
iii. Respiratory System—	
Codeine phosphate	15-60 mg.
iv. Circulatory—	
Antazoline hydrochloride (Antistin)	100-200 mg.
Diphenhydramine hydrochloride (Benadryl)	2·0 mg./kg.
Mepyramine maleate (Antisan)	5-10 ml of 2½% sol.
Promethazine hydrochloride (Phenergan)	2·5-10 ml. of 5% sol.
Iron dextran — 100 mg. Fe in 2 ml.	2 ml repeated in 10 days
Sodium bicarbonate	8·0 G.
Sodium sulphate (or magnesium sulph.)	15-30 G
Potassium iodide	0·5-3 G.
Calcium borogluconate	6·0-20 G.
Quinine	0·3-1·0 G.
Sodium salicylate	0·3-1·0 G.
v. Nervous System—	
Chlorpromazine hydrochloride	2 mg./kg
Powdered opium	0·3-1·0 G
Morphine salts	30-60 mg
Pethidine hydrochloride	3·0-5·0 mg./kg.
Tubocurarine chloride	0·075 mg./kg.
Suxamethonium chloride	2·0 mg./kg.
Chloral hydrate (oral narcotic)	2·0-4·0 G.
Chloral hydrate (i/v. deep anaesth.)	6·0-8·0 G./kg.
Pentobarbitone sodium	20-30 mg./kg.
Thiopentone sodium	*11·0-7·7 mg./kg* *
Chloroform (induction dose)	8-15 ml.

* With this drug, the larger the pig, the smaller is the dose/kg

Procaine solutions, 2 per cent. maximum dose	80 ml.
Nux Vomica Dry extr.	30-150 mg.
Strychnine salts	2-8 mg.
vi. Urinary Preparations—	
Hexamine	1·3-2·6 G.
Tinct. Hyoscyamus	2·0-6·0 ml.
vii. Genital Tract—	
Pituitary extract (post. lobe)	30-50 i.u.
Testosterone	50-100 mg.
Progesterone	50-100 mg.
Serum Gonadotrophin—Anœstrus	1,000 units
Serum Gonadotrophin—Non-ovulation	500 units

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